ECONOMIC ANALYSIS OF FARMERS-MANAGED IRRIGATION SCHEMES IN TANZANIA: A CASE OF MOMBO, KIVULINI AND LEKITATU IRRIGATION SCHEMES

BY

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ABSTRACT

The fact that evaluating economic performance of irrigation schemes are important and therefore needed at regular intervals is actually the motivation behind this study. Major objective of the study is to provide information that can be used to improve performance of the Farmer Managed Irrigation Schemes in Tanzania in terms of; economic returns to farmers, water use efficiency and productivity, operation and maintenance and sustainability of the schemes. The study area covered three farmer managed irrigation schemes Mombo, Kivulini and Lekitatu all located in Kilimanjaro irrigation zone. Descriptive statistics such as frequency distribution, percentages, cross tabulation, means, maximum and minimum values and standard deviations were used to characterize the sample households. Farm Enterprise Budget employed to determine the profitability of major crops farmed in the schemes. Economic performances and sustainability of irrigation schemes were also determined. In addition Residual Imputation Method was employed to evaluate economic value of irrigation water. To capture the effects of several hypothesized factors on scheme performance and farmers' income, multiple regression analysis was estimated. Results show that major crops grown includes paddy supplemented by maize, beans and vegetables. Average profitability from farming for 2006/07 season observed to be Tsh 1 162 751.16 per household including both major and supplementary crops. Average crop yields observed to be 3.87, 0.55, 0.22 and 0.77 tones/ha for paddy, maize, beans and vegetables respectively. The study also shows that the average value of irrigated water is 14.79 Tsh/m^3 and that the estimated average water productivity for paddy is 0.05 kg/m^3. Regression analysis results showed that all coefficients attached to the estimated parameters as expected were positively related to the dependent variable and that the majority was statistically significant ($p>0.05$). The study generally concludes that although there are many problems facing farmers in the farmers-managed scheme it is nevertheless profitable engaging in farming in such schemes. It therefore recommends some joint effort among stakeholders in order that farming in these schemes is improved.

DECLARATION

I, Erastus William Mkojera, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my original work and that to the best of my knowledge it has not been submitted to any other university for a degree award**.**

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DEDICATION

This dissertation is dedicated to my father the late Mr. William Hosein Mkojera and my mother the late Mrs Costansia William whom together laid the foundation of my education. In addition, it is also dedicated to my wife Agnes and our children Emmanuel, Christina and Heaven-light.

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LIST OF ABBREVIATIONS

AC	-	Access to credits
ASDP	-	Agricultural Sector Development Programme
ASDS	-	Agricultural Sector Development Strategy
CPT	-	Capital
DADP	-	District Agricultural Development Plan
EDU	-	Education level of the respondents
FAO	-	Food and Agriculture Organization
FMIS	-	Farmer Managed Irrigation Schemes
FS	-	Farm size
GDP	-	Gross Domestic Product
GMIS	-	Government Managed Irrigation Schemes
GoT	-	Government of Tanzania
ha	-	Hectare
IG	-	Irrigators Group
IMT	-	Irrigation Management Transfer
IWA	-	Irrigation water availability
IWMI	-	Irrigation Water Management Institute
JICA	-	Japan International Cooperation Agency
KATC	-	Kilimanjaro Agricultural Training -Centre
Kg	-	Kilogram
LO	-	Type of land ownership
MAFS	-	Ministry of Agriculture and Food Security
MWLD	-	Ministry of Water and Livestock Development
NEP	-	National Environmental Policy
NGO	-	Non Governmental Organisation
NI	-	Net Income
NIA	-	National Irrigation Agency
O&M	-	Operation and Maintenance
PRA	-	Participatory Rural Appraisal
PRb	-	Price for beans
PRm	-	Price for maize
PRp	-	Price for paddy
PRSP	-	Poverty Reduction Strategy Paper
PRv	-	Price for vegetables
R^2	-	Coefficient of determination
ROVC	-	Revenue Over Variable Costs
SNAL	-	Sokoine National Agriculture Library
SPSS	-	Statistical Package for Social Sciences
SUA	-	Sokoine University of Agriculture
TARP II	-	Tanzania Agricultural Research Project II
TFC	-	Total Fixed Costs
TIB	-	Technical information base
TNCID	-	Tanzania National Committee for Irrigation and Drainage

TR	-	Total Revenue
TVC	-	Total Variable Costs
TVP	-	Total Value of Production
UNESCO	-	United Nations Education and Science Cooperation
URADEP	-	Upper Region Agricultural Development Project
URT	-	United Republic of Tanzania
UWAMALE	-	‘*Umoja wa Wamwagiliaji Maji Lekitatu*’
VMP	-	Value Margin Product
WE	-	Water use Efficiency
WUA	-	Water Users Association

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Irrigated agriculture provides about 40 per cent of the world's food production from 18 per cent of the world's cultivated land (World Bank, 2003). During the past two decades drought has caused major production setback over wide areas of the tropical African countries (FAO, 2000). Irrigated land is far more productive than rain fed land, and the expansion of irrigation acreage over the past 30 years has contributed to gains in food production (Mwakalila and Noe, 2004). Report by FAO (1997) argue that irrigation if introduced and managed properly, can increase yield of the most crops by 100 to 400 percent in the developing countries; however, some of the world's most needy farmers are still unable to water their land effectively. Increased agricultural production to feed the world's growing population could have therefore been possible by increasing and/or intensifying the irrigated lands (Dorsan *at el.,* 2004).

Besides the facts that irrigation is the crucial ingredients in the agricultural progress of the tropical African countries; it should be understood that irrigation establishment is a complex technique requiring not only heavy and costly investments but also sensitive to error in planning, construction and management after establishment. The total area under irrigation in Africa is very small, estimated to be about 10 million hectares (FAO, 2000). Irrigation potential in Tanzania is estimated to be over one million hectares, of which only about 200 000 hectares (20%) are currently under irrigation and that out of the mentioned area under irrigation more than 80% fall under traditional small scale farming (TARP II – SUA Project, 2004).

The Tanzanian economy still depends on agriculture as its mainstay. During the recent years, the contribution of agriculture to the total GDP has been around 45 per cent and engages 82 per cent of the labour force (URT, 2007). The ratio of non-monetary agriculture has been relatively high (44 per cent on average), underscoring the importance of production for own consumption (Mwakalila and Noe, 2004), and that this non-monetary contribution is large because most farmers operate small-scale farms that contribute 70-80 per cent to total employment.

However, one of the major constraints to growth in agriculture is the continued reliance by small-scale farmers on hand-hoe cultivation in rain-fed agricultural systems. The continued dependence on rainfall in agriculture has proved incapable of sustaining the population increase. Irrigation development therefore holds the potential for reducing drought risks and increasing intensive production and that it is important for improvement in farm incomes for the majority of the rural population in Tanzania.

1.2 Problem Statement

It is now widely understood that irrigation systems will not be able to perform as needed without basic institutional reform, and which means devolution of some or all responsibility for irrigation management to the primary beneficiaries i.e. farmers in the schemes (Vermillion, 1999). During the recent decades, there has been an increasing amount of effort to transfer the management of irrigation schemes from government organizations to non- governmental organizations, as decentralized gained momentum and as states started to transfer some of their functions to different groups in the society (Dorsan *et al.*, 2004).

The decision by the government of Tanzania to focus on farmer managed irrigation schemes came as the best alternative to the failure or under performance of both the imposed smallholder irrigation and government managed irrigation schemes practices (Chemka, 1996). Although the decision had been made that it is better now to focus on the farmer-managed irrigation scheme rather than dealing with the centralised irrigation system, the study to evaluate the performance of these farmer-managed schemes is lacking. The requirement is also insisted in the report by FAO (2000) when commented that, evaluating irrigation and economic performances of smallholder irrigation schemes are important and therefore needed at regular intervals.

There are relatively a good number of studies on irrigation efficiencies as compared to the studies on the farmers' farming technique employed, scheme sustainability, management, economic performance and identification of roles and responsibilities of important stakeholders in improving farmer-managed schemes performances (Adams *et al.*, 1994). It was against this background that this study became a necessary step to undertake.

1.3 Justification

Economic analysis study attempts to contribute to a better understanding of the smallholder irrigation sub-sector, in order to be able to derive lessons from past experiences for the planning of future irrigation projects (FAO, 2000). In 1996, Chemka carried out a study to compare the performance between the farmers managed and the government managed irrigation schemes. The study was conducted in Mbeya Irrigation Zone at Kapunga irrigation project. Ten years back is a long time and considering the dynamism not only of the farming practices and techniques but also on agriculture policies and strategies, this worthy conducting another study to evaluate productivity, economic and financial profitability and sustainability of these farmers managed irrigation schemes. Moreover, Tanzania is a very large country with diverse culture and the fact that the former study was conducted in the southern part of the country, conducting another study in the northern part i.e. in Kilimanjaro Irrigation Zone, fill the information gap on research findings existed due to location variations.

Based on the key research findings, the study provide recommendations on policy, interventions and institutional arrangements for making irrigated agriculture effective in improving economic benefits. The study also give suggestions that are important tool to all stakeholders on the best way of mobilizing and directing resources from various sources aiming at improving performance and sustaining farmer managed irrigation schemes, hence increasing productivity and profitability to the beneficiaries.

1.3 Objectives of the Study

1.3.1General objective

The main objective of the study is to provide information that can be used to improve performance of the Farmer Managed Irrigation Schemes in Tanzania in terms of; economic returns to farmers, water use efficiency and productivity, operation and maintenance and sustainability of the schemes.

1.3.2 Specific objectives

i. To examine crop profitability, crop productivity and economic performances of the schemes.

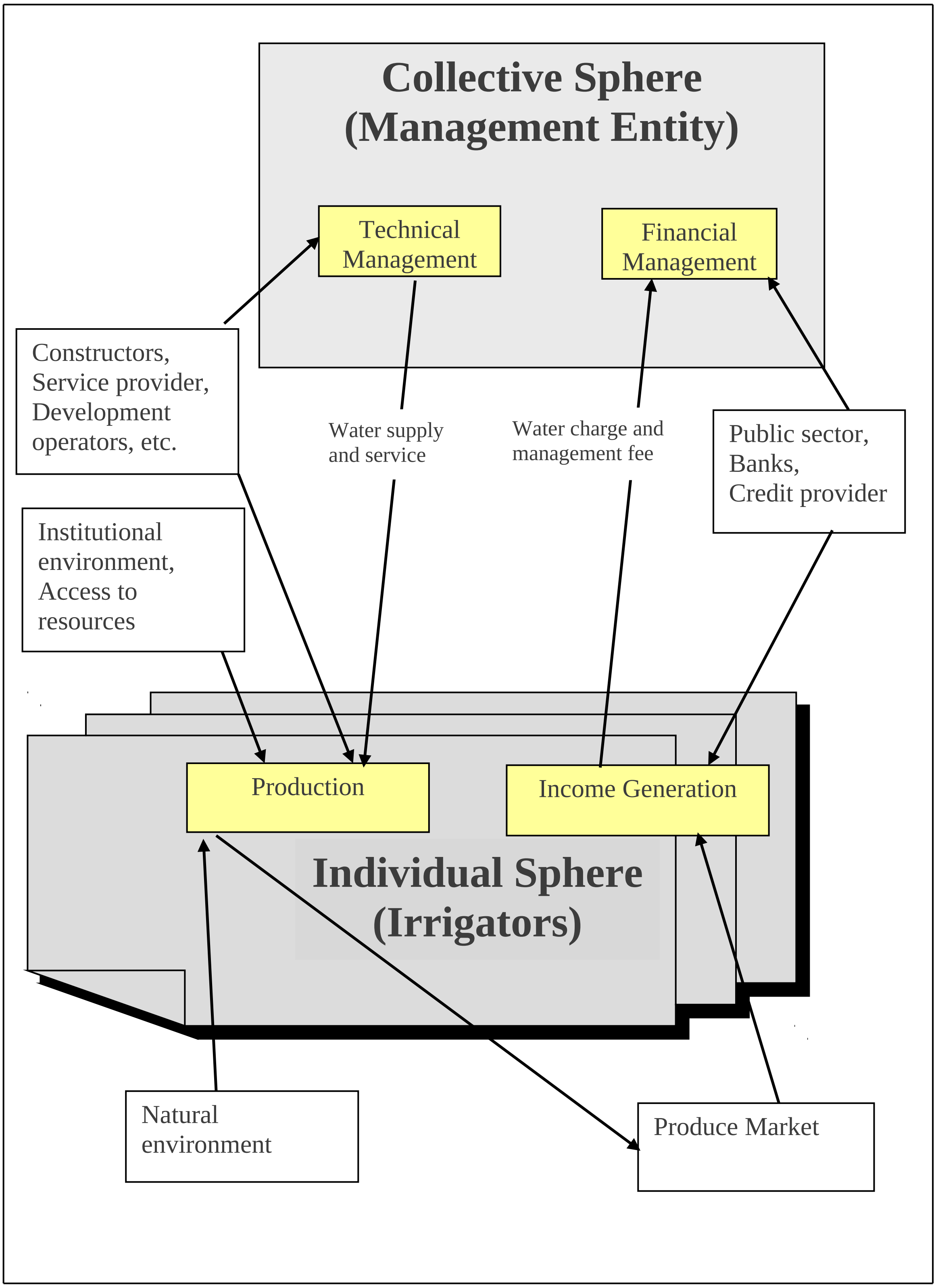
ii. To assess farmers technical efficiency in irrigated water utilization in the schemes in terms of water use efficiency and productivity.
iii. To determine the rate of farmers contribution and involvement in carrying out operation and maintenance activities in the scheme.
iv. To identify factors that influence performance of the farmers-managed irrigation.

1.3.3 Hypothesis

i. Farmer managed irrigation schemes are not operationally efficient.
ii. Irrigation water is not efficiently utilized in farmer managed schemes.
iii. Socio-economic characteristics of farmers do not affect water use efficiency regardless of the management types.
iv. Technical and institutional factors do not influence farmers' income in the farmer-managed schemes.

1.4 The Conceptual Framework

A conceptual framework provides understanding of the theoretical relationships between important variables and economic performance of the scheme. Figure 1, represents the framework for irrigation scheme's operation. It is a conceptual framework and an analytical framework as well, as it provides guidelines for multidisciplinary and comparative analysis and stimulates participation among different stakeholders. These frameworks attempt to integrate functions that take place at different dimensions and stakeholders involvement in the schemes' operation. The management of a scheme involves three types of stakeholders: the individual farmers, the management entity and external role-players. The external role players include the public sector (central and local governments), contractors and service providers, banks and the marketing or food processing sector. All provide financial or technical support to the management entity and/or to the farmers.



Source: Adopted and modified from Perret *et al*. (2003)

Figure 1: Operation of an irrigation scheme (A conceptual framework).

1.4.1 Individual sphere

At the individual sphere (irrigators), the focus is at production and income generation. Here types of crops grown and cost factors related to production such as inputs and operation costs, availability and access to markets, product prices which basically determines income of an individual farmer are considered. The level of income determines the ability to pay water charges and repayment of production loans if any. At farm level water is consumed individually without being measured or charged for. Individual farmers should transform this water into products through their production systems, and convert it to money by marketing their products.

The natural environment influences the production process (e.g. climate and soils, weeds, pests etc). On the other hand institutional context has impact onto production; especially the rules on accessing resources (e.g. land tenure, inner water-sharing features, and water rights). Farm income influences production, since it defines the level of intensification and diversification. Finally, constructors and service providers, the public sector (extension) also influence the production process. Constructors are responsible for construction and/or rehabilitation works, which includes irrigation infrastructures, farm roads, etc; whereas service providers ensure the availability and timely supply of production inputs to farmers. Public sector imparts know-how on improved farming techniques through extension services delivery.

1.4.2 The collective sphere

The collective entity (farmer’s organization or scheme management) provides irrigation water and related services to farmers, for them to produce. It technically manages, operates and maintains the scheme as a whole and in so doing it incurred some costs. The concept of having financial transaction supposes a financial management. Funds are collected from the farmers, and managed at scheme level.

Technical management, which is the component within management sphere, ensures water supply and services to farmers. It also receives inputs from service providers, constructors, and other development operators who mainly deal with the laying down and/or rehabilitation works of the hardware aspects of the scheme such as intakes, canals, farm roads, water distribution boxes etc.

Financial management on the other hand, is an important component within collective sphere that is responsible for all financial matters in the scheme like collection of water charges and management fees from farmers to strengthen financial capacity of the scheme. It also links with financial institutions like credit providers and banks through which, a scheme and even individual farmers can receive financial assistance and services in an agreed conditions.

Input procurement structure and marketing structures are crucial components of collective actions as they allow for access to production inputs and market of the produce. Management styles the scheme opts for have direct influence on services provision to farmers; hence affects scheme performance. In some schemes the access and timely availability of production inputs has no defined system leaving farmers uncertain to whether and when inputs becomes available not mentioning their prices fluctuations. A good scheme management system in the other hand is supposed to have in place an active marketing committee that properly and effectively handle all matters related to input procurement and marketing.

CHAPTER TWO

LITERATURE REVIEW

2.1 Global Changes in Irrigation Schemes Management

Over the past three decades, government in both developed and less developed countries have transferred public companies and other state enterprises to the private sector (Johnson, 2002). While originally concentration was in the manufacturing and transportation sector, privatization has now extended to almost all sectors of the economy, including the provision of water services such as potable water and irrigation (Johnson, 2002).

Increasingly, countries have embarked on a process of transferring the management of irrigation system from government agencies to water users' organizations (Perret, 2002a). However some countries are still unsure about whether or not to adopt reforms and how to design and implement them (Perret, 2002b). This process, the so called irrigation management transfer (IMT), includes state withdraw, promotion of the participation of water users, development of local management institutions, transfer of ownership and management, and thus has a broad objective of increasing irrigation performances and reducing demands on the public budget (Perret, 2002c; Perry, 2001).

2.2 Current Status of Irrigation Development in Tanzania

In Tanzania many small rivers and springs have been harnessed for irrigation forming schemes. Due to farmers limited resources these schemes usually cover relatively small area and also score very low on water management, farmers organization operation etc. It is the common phenomenon to have their intake structures frequently replaced after each floods, much water being wasted before reaching the plots, many plots not properly irrigated due to poor plot levelling etc. Kalanzi Smallholder Irrigation scheme is a good example of a traditional irrigation system. The system has been built and is managed by the local people and there have been no external interventions to modify the system. Photo1 shows the intake of Kilanzi scheme. Tanzania national committee for irrigation and drainage argue that, irrigation in the form of traditional irrigation schemes goes back hundreds of years in the country (URT, 2007) and that those schemes have however become inadequate due to increase in population, wear and tear, catchments degradation etc.

According to Mnzavas and Makonta (1994), irrigation development in Tanzania has gone through in three stages: First, there was an imposed smallholder irrigation practice. The second was large scale, Government-Managed Irrigation Schemes practices in which only the government was involved in irrigation development. The third stage is the farmer-managed irrigation system. In the first two stages there were no farmers' involvements in planning, designing and constructing scheme, also farmers' responsibility in operating and maintaining schemes were not clearly defined. The third stage therefore, came as a result of the poor performance of the government owned irrigation schemes where the government now emphasizes on the development of the farmer managed irrigation schemes, in order that irrigation farming attain efficiency and sustainability. All three types of irrigation scheme still exist in the country but at different magnitude. To contain the situation, the Government of Tanzania decided to improve small holder farmer's schemes whenever possible.

A study on the National Irrigation Master Plan (URT, 2007) estimated that by the year 2002 irrigation potential was 2.1 million ha in mainland Tanzania, while for Zanzibar was estimated to be 8 521 ha. The study further revealed that most of the irrigated areas are under surface irrigation, mostly used by smallholders and that water distribution is usually by lined and unlined canals where furrows and basins are widely used.

Since 2001, the Government of Tanzania (GoT) has been promoting the Agricultural Sector Development Program (ASDP) and the District Agricultural Development Plan (DADP) under the Agricultural Sector Development Strategy (ASDS). Under the ASDP/DADP framework, Development of irrigated agriculture, including irrigated rice farming is one of the pillars of the agricultural sector.

The primary reason for irrigation is to improve agricultural productivity in areas where surface soils are naturally drier. Semi-arid regions often have higher agricultural productivity if irrigated. However, given the large demands placed on water resources by irrigation, the extent of irrigation development has major implications for other water uses, including water needs for domestic, industries, and hydropower, as well as for national parks, wetlands and estuaries. Sustainable irrigation, therefore, refers to sound operation and maintenance of irrigation system that does not degrade entire ecosystems or create conflicts with downstream uses while improving social and economic benefits.

Plate 1: Intake of Kalanzi Traditional Irrigation Scheme.

2.3 Small scale Irrigation Development Opportunities in Tanzania

Tanzania has over one million hectares of potential irrigable land. This includes land for irrigation from surface water and underground water sources. By the year 2000, only about 200 000 ha of this land were under irrigated agriculture, both partial and full scale irrigation where the traditional small scale accounted for 80% and the rest were under large scale estate farms (URT/ASDS, 2001).

Training on new methods of irrigation and better water and soil management practices is perhaps the most valuable assistance that can be provided to farmers (FAO/UNESCO, 1973). Mrema (1984) identifies the following essential factors that might make small scale irrigation scheme successful: the scheme must be centrally managed, that is, the interests of the individual farmers must be subordinate to the interests of the scheme, the availability of well trained and multi-disciplinary extension manpower and essential inputs. Adams *et al.* (1993) suggested that it has became clear that the future approach to irrigation in sub-Sahara Africa will need to be substantially different from that adopted in the past. He further commented that the potential for enlarging the actual areas of farm land is limited in some countries, so in order to increase output it is deemed necessary to improve productivity of the existing farm lands.

Sustainability of small scale irrigation schemes on the other hand requires orientation to the markets i.e. commercial agriculture. Monetizing small scale agriculture is necessary for farmers to be able to pay water and other charges required. To meet this, farmers required to have different objectives i.e. to maximize cash income in addition to attaining food self sufficient which is the main objective of subsistence farmers. In retrospective, markets for products need to perform rather well in such situation.

2.4 The Role of National Policies on Irrigation Development

Government policy would have to recognize that water is an economic good as well as a social good (Langford, 1999). This principle is consistent with the 'Dublin Statement' of the International Conference on Water and the Environment of 1991 which was agreed to by over 100 countries. Government policy should also recognize the principle that irrigation schemes must be demand and not supply driven. The role of government should be to facilitate the development through appropriate policy and legislation to create commercial discipline and clear accountabilities. Ideally, governments should not be directly involved in constructing and managing the commercial operations of an irrigation authority.

The policy environment is critical to irrigation development and management, as it provides the framework of national goals and requirements within which regional and local aspirations are to be met. In Tanzania policies most directly or indirectly impinging on irrigation development/management are such as: The National Land Policy; National Agricultural Policy; National Water Policy; National Environmental Policy and Social policies.

In Tanzania, the *Tanzania's Development Vision 2025* provides the guiding frame-work for the agricultural and other sectoral policies. The vision is for the country to move from a less developed country to a middle-income country by 2025, with a high level of human development. Specific targets include: a high quality livelihood, which is characterized by sustainable and shared growth (equality), and freedom from abject poverty; good governance and the rule of law; and a strong and competitive economy capable of producing sustainable growth and shared benefits. Along with this vision is the *Tanzania's Poverty Reduction Strategy Paper* (PRSP), which was launched October 2000. The PRSP sets out the country's medium term strategy for poverty reduction and the indicators it will use for measuring progress. It views irrigated agriculture as an important strategy for increasing food security.

The main objective of the National Agricultural Policy of 1997 is to ensure food security at national and household levels. However, this objective can be achieved through high crop production which can only be achieved if the application of water (irrigation) is done well and the fields are well prepared (Mwakalila and Noe, 2004).

The objective of the National Water Policy (URT, 2002) for Water Resources management is to develop a comprehensive framework for promoting the optimal, sustainable and equitable development and use of water resources for the benefit of all Tanzanians, based on a clear set of guiding principles. Therefore, good irrigation management is needed such that each water user gets the amounts of water desired at the right time and ensures that water is available throughout the year, or at least when needed. Through this kind of management, irrigated agriculture can improve household income.

The National Environmental Policy (NEP) encourages good irrigation management to reduce undesirable environmental impacts such as soil salinity, water pollution and the spread of waterborne diseases. This kind of management could lead to sustainable irrigation for poverty alleviation.

Social and development policies have important indirect effects on water use and management. Water use conflicts in the community could be avoided if proper irrigation management was put in place (i.e. good water allocation and distribution).

The Agricultural Sector Development Strategy (URT, 2001), Ministry of Agriculture and Food Security stipulated that, the proposed National Irrigation Policy should be comprehensive and robust taking into consideration:

- ✓ Different water users;
- ✓ Competitive water demands;
- ✓ Sustainability of irrigation development and management;
- ✓ Targeting the poor (pro-poor);

2.5 Performance of the Irrigation Schemes

There is a general awareness that irrigation management has been weak in many African countries for both government and farmer-managed irrigation schemes (Speelman, 1990). Recent studies on the performance of irrigation systems shows that in general the performance of many irrigation systems has fallen due to poor organization and management (Sagardoy, 1986). Therefore in the process of transferring irrigation schemes from government to farmers, the government has to intervene to help farmers conduct irrigation activities in a better way (Martin *at el*., 1986). Vermillion and Sagardoy (1999) defined the concept irrigation management transfer as follows, "the reallocation of responsibility and authority of irrigation management from government agencies to non-government organization, such as water users associations, and that it may include all or partial transfer of management functions and may also include full or partial authority".

2.5.1 The government managed irrigation schemes (GMIS)

Tanzania is among few African Sub-Sahara countries which has brought the subject of irrigation to the forefront in their agricultural priorities, and that by 1982 she had an estimated 25 000 ha of modern (large scale) irrigation schemes constructed by the Tanzania government with great foreign assistance (Balirwa, 1990). Here we define Government Managed Irrigation Schemes as those schemes in which the principal management responsibility is exercised by government agencies with the farmers playing subsidiary roles.

In many countries, institutional weaknesses and performance inefficiencies of public irrigation agencies have led to high cost of development and operation of irrigation schemes. In addition, poor maintenance culture and lack of effective control over irrigation practices have often resulted in the collapse systems. Moreover, irrigation agencies have largely been unable to raise sufficient revenues from collection of water charges to meet operational expenses. Consequently, deteriorating government fiscal position in the face of mounting operation and maintenance costs of the irrigation agencies have provided the stimulus for many governments to adopt programs to devolve responsibility of irrigation management to users groups (Johnson *et al*., 1995). Indeed, these efforts towards the improvement of irrigation management performance are consistent with current tendencies, mainly driven by structural adjustment policies, to reduce the size and cost of government by devolving responsibilities and activities to the local level (Shah *et al*., 2001; Meinzen-Dick and Knox, 1999; Kiss, 1990). They are also motivated by growing optimism that communities or user groups may be able to effectively manage the resources to ensure efficiency, equity and sustainability (Meinzen-Dick and Knox, 1999).

Langford (1999) described the failure of the government managed irrigation schemes as caused by the way those schemes established that:

- ✓ The establishment based on social not economic policy objectives. In Australia for example social objectives of closer settlement guided government investment in irrigation schemes, settling large numbers of returned soldiers after the two world wars, and creating a class of prosperous small farmers were two of the specific objectives. It is not surprising that the economic performance of the irrigation schemes developed under these social policies leaves a lot to be desired.

- ✓ The establishment also based on supply not demand driven. The development of irrigation was driven from the supply side. Water supplies were secured before consideration was given to what irrigation enterprises would deliver the best economic return. Marketing, in the true sense of the word, to assess the potential markets and likely profitability of particular irrigation enterprises was a secondary consideration.

- ✓ There was lack of commercial discipline in investment decisions. While the early promoters of private irrigation schemes had sought full cost recovery by charging sufficient for water to recover operations, maintenance, administration, depreciation and a return on capital, typically revenue from water deliveries did not even recover operating costs. Rate of return on the investment was not a significant factor. The strong political and technical forces driving irrigation development led to much greater scale of irrigation development than could be justified on economic grounds.

- ✓ Commercial discipline in water allocation was also lacking. In order to encourage farmers to use new water allocations no capital charges were levied for access to the water. Farmers had to encouraged to take up the over supply of water from the multitude of new irrigation schemes. It is not surprising that large volumes of water were allocated to enterprises with low profitability. Irrigation of pastures and rice for example use large volumes of water but generate much lower returns per unit volume of water than horticulture.

A study by Balirwa (1990) on an economic analysis of large scale irrigation schemes, a case of Dakawa rice farm, which were basically government managed scheme revealed that, such schemes in Tanzania were characterized by low yields, high unit costs of production, liquidity problems and return to assets being far below opportunity costs of capital. Langford (1999) identify the role of government that should be to facilitate the development of larger scale integrated water supply systems for irrigation and that it should commission the conceptual plans for potential irrigation schemes, and create the legal and institutional framework. He further stipulated roles of the government in irrigation schemes to be:

- ✓ To prepare a conceptual plan for the new irrigation scheme setting out the area potentially available for irrigation and the potential storage sites;
- ✓ To appoint a resource manager to provide policy advice on all matters related to water resources management including water allocation policy and practice.
- ✓ To license a private sector operator to construct and manage the irrigation water storage and delivery system
- ✓ To appoint an economic regulator to oversight pricing for storage and transport of water, including investment in asset renewal and service levels.
- ✓ To appoint a manager to be accountable for managing any environmental water allocations;

The experience on the operation of irrigation schemes in Ghana as revealed in a study by Osman (2001) on determinants of success of community-based irrigation management in northern Ghana shows that, many small-scale irrigation schemes, which are government managed, based on earth dams and dugouts exist, and that many were funded under World

Bank projects (including the Upper Region Agricultural Development Project - URADEP) in the 1970s. The majority of these schemes have there structures broken down over time due to poor maintenance and the resulting siltation problems. He farther reported that several donor agencies, government organizations and NGOs are involved in the rehabilitation of these schemes and the construction of new ones, which are to be managed by farmers. Indeed, close to 90 percent of rehabilitated small schemes are now controlled by farmers; he added.

Rapid expansion of irrigated area during the last century created several irrigation management problems on all over the world. Dorsan *et al.* (2004) reported that experience on irrigation management in Turkey showed that the management of irrigation schemes by government organizations and their bureaucratic mechanisms has generally resulted in insufficient financial sources for operation and maintenance costs. The centrally financed bureaucracies lack the ability and capacity to provide proper water management for public irrigation schemes. Consequently, these schemes face several challenges like deterioration of irrigation and drainage infrastructure, misdistribution and misuse of water and occurrence of salinization problems.

2.5.2 The farmer managed irrigation schemes (FMIS)

Farmer Managed Irrigation Schemes are defined as those schemes in which most management activities are carried out and decisions made by the farmers themselves with the government providing technical and logistical support. Farmer managed schemes can be developed by the government but owned and managed by the farmers' Irrigation Management Committees, with minimal government interventions in terms of management. In Tanzania under the current devolution and decentralization exercise of smallholder irrigation management, it is important that farmers put in place proper monitoring and evaluation mechanism to ensure the efficient use of resources i.e. water and infrastructure.

Ntsonto (2005) reports the situation in South Africa that, smallholder (farmer managed) irrigations schemes accounts for about 4% of the irrigated area in the country and that in spite of such relatively small contribution, it is believed that those schemes could play an important role in rural development, since they can potentially provide food security, income and employment opportunity. Many governments have found it increasingly difficult to finance the costs of irrigation operation and to be effective providers of water services to large numbers of the smallholder farmers that governments are now attempting to transfer management responsibilities for irrigation system from government agencies to farmers organized into water users associations (Ntsonto, 2005). Actually the devolution of the irrigation management system from being centrally governed by the government or governmental agencies to farmers supposes the necessity to improve irrigation schemes performances.

A major premise of the devolution theory is the argument that local water users have the strongest incentive to manage that resource more efficiently and sustain ably than the centrally financed government agency because of better local supervision (Meizen-Dick and Knox, 1999). Successful devolution however requires that effective local institutions be in place and that public policy be supportive of local management.

Participation by farmers in system design and management helps to ensure the sustainability of the system, reduce the public expenditure burden, and improve efficiency, equity, and standards of service. Mobilizing support at all levels and establishing the participatory process, however, involves costs; it also demands knowledge of the incentives facing each group of stakeholders and of the essential elements in building effective user organizations.

2.6 Economics of the Farmer Managed Irrigation Scheme

Tanzania, like many other African countries has been struggling for many years to improve agricultural production and productivity of its various crops with limited success. Many rural improvement program have come and gone, but much still remains to be desired when one looks into the situation of the rural areas which are still characterized by low productivity of land and labour, insufficient food, ignorance and disease to mention only a few.

It is basically searching for ways to increase food production in order to reduce the need for costly food imports and provide a means of agricultural production to feed the nation and to generate farmers' income even when rains fails. Increasing and stabilizing food and agricultural production is important to the governments' goal of food self-sufficiency as well as to the industrial sector where many agricultural processing plants operate below capacity (Orota, 1993).

The potential of irrigated agriculture in enhancing food security and alleviating poverty has led to many governments in developing countries to point out sustainable agricultural development through "wise use" of water resource as one of the fundamental goals in their national policies (Kadigi *at el.*, 2004). Hazlewood and Livingstone (1982) argued that, small scale irrigated farming has the advantage of economizing scarce management in using family labour and in distributing widely the benefits of irrigation.

One of the leading causes for the low crop yield in Tanzania is unstable rainfall during cultivation season because most of the crops including rice in the country had been grown under rain fed condition. Therefore, the government of Tanzania constructed many irrigation schemes targeted for irrigated crops cultivation including rice in order to increase the crop yield so as to boost the crop production to meet the national demand. However, the intention had not been realized in most of the schemes mainly due to the inadequate scheme management skills and proper knowledge and techniques on irrigated crop cultivation on the side of farmers. Although the infrastructures of irrigation schemes were constructed through the joint efforts among beneficiaries, governmental organizations and donors, the software aspects such as scheme management know-how and proper cultivation techniques were not covered in most of the cases.

2.6.1 Management and farmers' organizations in the farmer managed schemes

Irrigated agriculture continues to face increasing challenge to produce more food to feed the growing world population in the face of dwindling water resources - erratic rainfall regimes, increasing competition for water (due to urbanization and industrialization), etc. (Gyasi, 2002). The need therefore to use water much more efficiently and productively especially in irrigation is more pressing. The recognition of limited efficiency of the state in managing this common-pool resource has justified the need for appropriate roles for farmers in the management process. Gyasi (2002) further argue that, governments are giving increased responsibility to community-based organizations to manage irrigation schemes, but the policy efforts will result in the expected effect only when farmers respond by increasing their participation in the management of the system.

Past analysis of irrigation management in Africa has focused mainly on assessing the efficiency or profitability of different schemes without much emphasis on the factors that condition households’ cooperation in collective management of irrigation schemes (Makombe *et al.*, 2001). The average rice yield in Tanzania for example, which is the main crop grown in most irrigation schemes, has being fluctuating between 1 and 2 tons per hectare over the period between 1980 and 1990, even though under irrigated conditions and the average yield currently is between 2.5 and 3.5 ton per hectare (URT, 2006); this is supposed to be the consequence of establishing irrigation schemes without proper scheme management structure. The success of participation efforts in the irrigation sectors depends on how well the project mobilizes support and builds effective farmers' organizations (World Bank, 2007).

Mwakalila and Noe (2004) in their study on the use of sustainable irrigation for poverty alleviation in Tanzania observed that; for improved irrigation system, water users were formally registered with the government as either an association or a co-operative. Associations are registered under the Ministry of Home Affairs, while co-operatives are registered under the Ministry of Agriculture and Food Security. A condition for being granted a statutory water right is that the holder of the right must be a legally registered body.

Smallholder irrigation management looks at how the farmers collectively manage the scheme for the sustenance of their livelihoods. Semakande *et al.* (2007) listed nine property rights that farmers' organizations need to have for optimal allocation and efficient use of resources in the scheme, with the on-going default hand over of the irrigation management to farmers as follows:

- ✓ **Water right –** The association and individual members have a right to a share of the water supply (of a useable quality) at the point of extraction from the resource base and at the level of individual users.
- ✓ **Right to determine crop and method of cultivation –** Individual water users, sometimes constrained by group imperatives, have the right to select which crops they will plant and how they will cultivate them.
- ✓ **Right to protect against land conversion –** The association has the right to protect its irrigated land against conversion to non-agricultural or non-water use purposes, in the event that the majority of members oppose such conversion. Irrigated land is the main revenue base to finance the association, recover investment costs, and ensure sustainable livelihood for members.
- ✓ **Infrastructure use righ**t **–** The association has the right to operate, repair, modify or eliminate structures. Without this right, the association is unable or unwilling to invest in long-term maintenance and repair and is likely to consider the infrastructure as the property of the government.
- ✓ **Right to mobilize and manage finances and other resources –** The association has the power to impose service fees, establish sideline revenue activities, plan and implement budgets, require labor or other inputs from members, recruit and release staff and provide training.

- ✓ **Right of organizational self-determination –** The association has the right to determine its mission, scope of activities (whether single function or multiple functions, including businesses), basic by-laws, rules and sanctions and method for selecting and removing officers.
- ✓ **Right of membership in organization –** All water users who are eligible for membership according to association by-laws have the right to be members of the association and receive its privileges, services and benefits--as long as they comply with its rules and obligations.
- ✓ **Right to select and supervise service provider –** Where members of the association are unable or unwilling to directly implement the O&M service by themselves, the association may appoint third parties (such as contractors) to implement required services. The association has the right to set the terms of such contracts and supervise service providers.
- ✓ **Right to support services –** Subject to government policies or agreed conditions, the association has the right of access to support services it needs in order to function properly. This may include access to credit, banking services, agricultural extension, technical advisory services, subsidies, conflict resolution support and other legal services, marketing assistance, training and so on.

2.6.2 Operation and maintenance (O&M) activities

Operation and maintenance (O&M) is crucial for the sustainable running of the scheme leading to better water use and hence improved agricultural output. The two, O&M and agricultural productivity, have a cause effect relationship, i.e., the sustenance of the one depends on the good performance of the other (Semakande *et al.*, 2007). In a well managed irrigation scheme under smallholder farmer managed scheme, farmers are responsible for the maintenance of infrastructure. Each farmer is responsible for the repair, maintenance and replacement of his/her infield infrastructure.

Schemes which do not pay for O&M costs, good irrigation water management are a problem. The ability of farmers to pay water use fee to cover the cost of O&M determines the self sustenance of the schemes. If such farmer-managed firm can sustain, the government can facilitate the establishment of such irrigation schemes by covering their initial costs of building the infrastructures and bearing other sunk costs, which most poor farmers are unlikely to meet.

Most of the literatures shows that governments has proved failure in managing irrigation schemes and that it’s deemed necessary for the farmers to have full mandate on managing and running the irrigation schemes. This argument stands on the premise that most studies evaluated the performance of the government managed irrigation schemes. This study therefore works on the other side of the coin that is evaluation of the farmer managed schemes.

CHAPTER THREE

METHODOLOGY

3.1 Location and Description of Study Area

To hasten irrigation development in Tanzania the government divided the country into seven irrigation zones, namely Kilimanjaro, Mbeya, Morogoro, Manyara, Tabora, Mtwara and Mwanza. Every zone covers several regions. Irrigation schemes selected for the study are Mombo, Kivulini and Lekitatu. All three are surface irrigated but with different background, commanded area and management structures. All of them are found in Kilimanjaro zone and fall under farmer managed irrigation schemes category. This zone is characterized by variation in weather condition, but Mombo and Lekitatu schemes which are in Tanga and Arusha regions respectively are relatively prone to mid-season droughts.

Mombo irrigation scheme is situated very close to Mombo town which is about 40 km from Korogwe town along the Dar – es – Salaam to Arusha road. The scheme has permanent water source, where water abstraction is by gravity and it has a night reservoir. The scheme commands area of 220 ha, divided between two blocks, A and B. It is fully operational and managed by farmers through a registered cooperative society. Farmers practice two overlapping seasons per year and the main crops grown are rice and maize. Lekitatu irrigation scheme is located some 30 km from Arusha, near Usa River town. It is the scheme typically developed, owned and managed by farmers. Comparatively, the scheme is younger than Mombo and it commands an area of 464 ha, fully operational but still under improvements. It has a permanent water source and the abstraction is by gravity. Main crops cultivated are rice and maize, although beans and horticultural crops especially vegetables are also grown.

Kivulini scheme is in Kilimanjaro region and it is proudly enjoying fairly adequate water supply. The scheme is in Mwanga District about 35 km from Moshi town along the Dar es Salaam road. The scheme covers an area of 810 ha. Out of which, 410 ha are suitable for rice while the rest 400 ha are suitable for maize and beans mainly. The scheme started rice farming back 1950s. Currently the scheme is owned by farmers, fully operational but partially improved. Farmers practice only one main season (long rain season) and during the short rain season they mainly grow some vegetables. For the most farmer managed irrigation schemes water is regarded as one of the most limiting factors to production, others being field conditions, scheme management and cultivation techniques (Samakande *et al.,* 2007). Table 1 summarizes characteristics of the selected studied schemes whereas Fig. 2 shows the location of the mentioned study areas.

Table 1: Summarized characteristics for Mombo, Kivulini and Lekitatu Schemes

Item		**Characteristics**	
Scheme Name	Mombo	Kivulini	Lekitatu
Zone	Kilimanjaro	Kilimanjaro	Kilimanjaro
District	Korogwe	Mwanga	Arumeru
Area (ha)	220	810	464
Main crop	Paddy	Paddy, beans, maize	Paddy, maize
Scheme owner	Scheme	Farmers	Farmers
Scheme type	Improved	Partially improved	Under improvement
Operation	Fully	Fully	Fully
Water right	Acquired	On process	Acquired
Water source	Permanent	Permanent	Permanent
Water abstraction	Gravitate	Gravitate	Gravitate
Plots owner	Farmers	Farmers	Farmers
Farmers organization	Mombo Irrigation Scheme Coop. Society	Being formed	UWAMALE Coop. Society

Source: KATC II Project (2002)

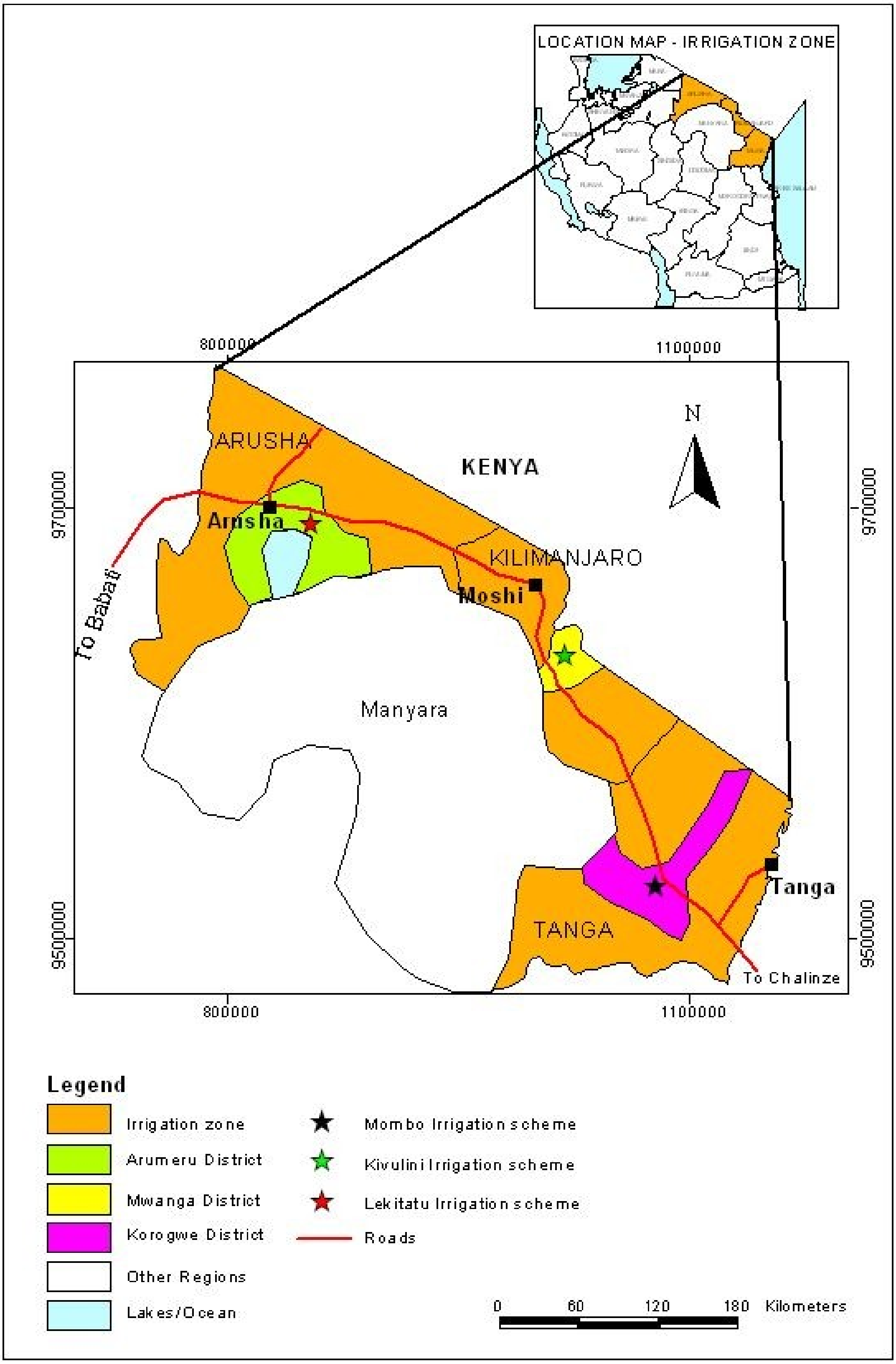


Figure 2: Map locating the study areas.

3.2 Research Design and Sampling

This study adopted a cross-sectional data. The design according to Babbie (1990), allowed data to be collected at a single point in time without repetition from the target population.

Three irrigation schemes all from Kilimanjaro irrigation zone were purposively selected. Although all three schemes are in the same zone, they are located in different regions all together. On top of that all three have differences in historical background, area commanded, number of beneficiaries and scheme status whether fully or partially developed and/or fully or partial operating. In each scheme respondent was randomly picked from the registration book in the scheme.

The study targeted farmers farmed in the schemes last season including both those owning plots and those hired some plots. It also interviewed leaders, technical personnel in the scheme, personnel responsible for guiding farmers in those schemes from the district as well as from irrigation zone offices. Data obtained from all these stakeholders assumed to be reliable and consistent.

The number of respondents in each scheme was determined using the criteria adopted by JICA/NIA (1991) where the irrigation area the scheme commands is used as the criteria for sampling number of respondents. However due to time and budget constraints little adjustment was made to the criteria as follows: From Mombo scheme, which commands 220 ha, 40 respondents instead of 50 was interviewed. In Kivulini scheme where the scheme commands 810 ha, 60 respondents instead of 70 and for the Lekitatu scheme with 464 ha, 60 respondents as well. Therefore a total of number of respondents from all three schemes was 160.

Table 2: Determining sample size using scheme size

Area (ha)	Number of respondents suggested by the criteria	Number of respondent after adjustment		
		Mombo	Kivulini	Lekitatu
201 – 300	50	40		
301 – 400	60			
> 400	70		60	60

3.3 Data Collection Procedure

3.3.1 Primary data

Primary data was collected using a structured and pre tested questionnaire. Questionnaires administered to farmers randomly selected but representing all blocks in the scheme. It was not possible to have all respondents collected at one point so enumerators took trouble to visit farmers at their farms. Participatory Rural Appraisal (PRA) method adopted in focus group interview. Omari (1997) qualified it as a cost-effective means of collecting data within a short period of time yet resulting into reasonably efficient and effective information.

Some PRA tools used included transect walks and interviewing key informants and extension officers in the schemes. “Key probes” which were investigations starting with questions also adopted as one of the tools because the experience shows that it normally lead to good information collection.

3.3.2 Secondary data

Secondary data were collected from the relevant sources, including Sokoine National Agricultural Library (SNAL), district agricultural and irrigation zone offices and from the Ministry of Agriculture, Food security and Cooperatives; Irrigation and Technical services Department.

3.4 Data Analysis

The information collected was coded and input to the computer for the analysis. Data was analyzed using statistical package computer software, where statistical package for social sciences (SPSS) and Microsoft Excel were the main programs used.

Generally the study utilized both statistical and descriptive analysis, including means, frequencies and cross tabulations to identify farmers' conditions, contribution rates to the operation and maintenance activities and constraints affecting farmers' income by and within schemes. Specific analytical tools was employed to evaluate crop profitability and productivity, economic performance, efficiency in water utilization, economic value of water and sustainability of irrigated land in the scheme.

3.4.1 Crop profitability

Crop profitability was estimated as one of the agro-economic indicator of the schemes. The profitability from main crops in the schemes was estimated using the farm enterprise budget analysis. Farm enterprise budgets represent estimates of receipts (income), costs and profits associated with the production of agricultural products (George and Jayson, 1994). Among various uses which such analysis can provide, farm budgets was used to estimate benefits and costs for major changes in production practices to evaluate the efficiency of the farm enterprises. The analysis considered powerful enough to be used to estimate the profitability of crops grown in the irrigation schemes because, it provides opportunity to include fixed costs and labour in the analysis.

The information in an enterprise budget can be organized in different ways, but it typically includes sections on gross income, variable costs, fixed costs, and net income above selected costs (Lessey *et al.*, 2004) so in this study the typical sections had been considered.

- **Gross Income**

  Gross income consists of level of output and price per unit of output. Therefore the gross income in this study estimated by multiplying the amount of crops harvested in kilogram or bags by the price of a given crop in the standard unit of measure used.

- **Variable Costs**

  Variable costs depend on the level of output produced. In this study variable costs included the summation of land preparation costs, crop management costs, hired and estimated family labour, inputs costs, water charges and other operating expenses incurred.

- **Fixed Costs**

  Fixed costs are those costs incurred regardless of whether or not output is produced. Building and machinery fixed costs include depreciation, interest on average investment, some repairs, taxes, and insurance. Land is an important input and should be valued, so if you own the land, an opportunity cost against the land is charged since one cannot use the capital investment in an alternative endeavour (Lessey *et al.*, 2004). In this study therefore fixed costs estimated include opportunity costs of land as land value, depreciation costs for farmer used tractors and power tillers, land rent charges and interest paid.

- **Income above costs**

Income above costs is the income remaining after covering the specified costs included in the budget. It is referred to as net income. The net income in this study was calculated by subtracting total costs (variable + fixed costs) from the gross income. First net income for every crop in each studied scheme is estimated, before estimating net income from all crops in a scheme and establishing average net income by and for all schemes.

- **Prices and valuation of labour**

Prices play an important role in economic analysis. Normally market prices are used, although there may be differences in prices right after harvest and the prices received after farmers have stored their produce. A decision between the uses of current prices versus constant price needs to be made before hand as it has implications in incorporating inflation in the calculation. Normally constant prices are used because of the assumption that general inflation will exert the same relative effect on both costs and benefits (Senkondo *et al.,* 2004). It is also difficult to forecast inflation beyond say three years. To reflect economic analysis in this study, prices used to value inputs and outputs were taken in such a way that transfer payments (such as taxes, subsidies and credit transactions) are eliminated. Although no adjustments were made in correcting price distortions of traded goods, this study opted for market prices which were believed to reflect the opportunity cost.

In this study therefore farm enterprise budget analysis was employed to evaluate profitability of the major crops grown in each scheme such that, in Mombo crops evaluated was paddy and maize while in Lekitatu and Kivulini schemes evaluated crops were four i.e. paddy, maize, beans and vegetables. In addition average profitability from all crops within and for all scheme were also evaluated. Data used were from individual economic data using average current prices, triangulated with other information collected using other approaches (e.g. participatory rural appraisal (PRA), transect walks, talking to the key informants and extension officers and secondary data).

Farm enterprise budget analysis used the following formula:

NI= TR – TC

TC = TFC + TVC

ROVC = TR – TVC,

Where:

NI = Net Income (profitability)

TR = Total revenue from the crops (quantity produced x Price of the produce).

TVC = Total Variable costs (Inputs, operations and labour costs)

ROVC = Revenue over variable costs ≡ Gross Margin.

TFC = Fixed costs (depreciation, taxes, interest on investment, land charges, salaried labour etc)

3.4.2 Return to labour

Return to labour was calculated in every scheme for the major crops grown. The average return to labour per crop and by schemes estimated before establishment of an average for all schemes. Labour in this study context referred to as the summation of family and hired labour used.

3.4.3 Crop productivity in the scheme

Productivity is normally measured as a rate of production per unit area (yield) when referring land productivity. The yield of the major crops in the schemes was evaluated. Every crop has the established optimal yield depending on the variety used, so evaluating the average realised yield suggested whether a given crop of a certain specified variety performed better or not. To calculate productivity the following mathematical expression adopted:

Mathematical expression:

$$\textit{Yield} = \frac{\textit{Total produce (tones)}}{\textit{Total area (ha)}}$$

3.4.4 Economic performance

The economic performance of the scheme refers to whether the scheme renders benefit to the society or a nation as a whole. The economic performance of irrigation schemes is assessed by using the criteria of efficiency of water fee collection and financial self sufficiency.

Dorsan *et al.* (2004), when conducting a study on Performance Evaluation of Transferred Irrigation Schemes of Lower Gediz Basin in Turkey, used the same criteria in assessing the economic performance. This study therefore adopted the same criteria in evaluating/assessing the economic performance of the studied schemes.

Water fee collection efficiency is estimated using the expression:

$$\text{Water Fee Collection Efficiency} = \frac{\text{Irrigation Fees Collected}}{\text{Irrigation Fees Due}} \times 100$$

The financial self sufficient of the scheme is calculated using the expression:

$$\text{Financial self sufficient} = \frac{\text{Total income to the scheme}}{\text{Total O\&M requirement}} \times 100$$

3.4.5 Efficiency in water utilization

Yield per cubic volume of water is one of the most useful indicators in assessing the technical efficiency of use of water (Nijman, 1992, cited by Kongola, 2000). This performance indicator reveals farmers technical efficiency in the use of irrigation water supply. Beside its ability to reveal irrigators' technical efficiency in irrigation water utilization, it has been reported that specific yield is nowadays widely used in place of yield per volume of water issued (kg/m^3). In this study therefore, specific yield per unit irrigated area was adopted to indicate the farmers' technical efficiency in irrigation water utilization.

$$\text{Water Use Efficiency} = \frac{\text{Total production}}{\text{Irrigated area}}$$

3.4.6 Economic value of water

The *Residual Imputation Approach* was used to derive the residual value of water. More often than not, evaluation of a proposed irrigation project is based on residual imputation of water values, which means that the combined economic worth of factors of production other than water is subtracted from commodity sales revenues, the difference between the two being assigned to water (Douglas, 2000). The “residual” method has been widely used to derive economic values of water, especially in irrigated agriculture (Hussan *et al*., 2001; Renwick, 2001; Young, 1996, cited by Kadigi *et al*., 2004).

Considering the production function process in which the crop out put Y is produced under irrigation by the following factors; Capital (K), Labour (L), and other natural resources e.g. land (R) and water (W):

The production function is:

$$Y = \int (K, L, R, W) \quad \ldots\ldots (1)$$

Assuming constant prices under competitive factor and product market;

$$TVP_Y = (VMP_K \times Q_K) + (VMP_L \times Q_L) + (VMP_R \times Q_R) + (VMP_W \times Q_W) \quad \ldots\ldots (2)$$

Where: TVP = Total value of product, Y

VMP = Value marginal product of resource *i*

Q = the quantity of resource *i*

Assuming VMPi = Pi, i.e. value marginal products equals prices of resources and then by substitution and rearrangement of the equation, it follows that:

$$P_W = \{TVP_Y - [(P_K \times Q_K) + (P_L \times Q_L) + (P_R \times Q_R)]\} / Q_W \quad \ldots\ldots (3)$$

This gives out the value of the shadow price of water (P*w*), which is basically the Economic Value of Water.

3.4.7 Factors affecting farmer income

In evaluating factors influencing farmers' income in the scheme multiple regression model was adopted. The factors examined include: farmers' characteristics (age, education levels and gender), farm size, irrigation water availability, capital, access to credits, technical information base, contribution of supplementary crops and type land ownership. The multiple Regression model:

$$Y_i = \beta_0 + \beta_1 AGE + \beta_2 EDU + \beta_3 GENDER + \beta_4 FS + \beta_5 IWA + \beta_6 TIB + \beta_7 LO + \beta_8 AC + \beta_9 CPT + \beta_{10} OCI + \beta_{11} PRp + \beta_{12} PRm + \beta_{13} PRb + \beta_{14} Rv + \epsilon_i$$

Where:

Y_i	=	Average income of farmers
β_0	=	Intercept
$\beta_1, \beta_2 \ldots \beta_{14}$	=	Coefficients
AGE	=	Age of the respondents
EDU	=	Education level of the respondents
GENDER	=	Gender (sex of the respondents)
FS	=	Plot size cultivated by the respondent for the season 2006/7
IWA	=	Irrigation water availability
TIB	=	Technical information base
CPT	=	Capital
LO	=	Type of land ownership
AC	=	Access to credits

OCI	=	Percentage contribution of supplementary crops
PRp	=	Price for paddy
PRm	=	Price for maize
PRb	=	Price for beans
PRv	=	Price for vegetables
ϵ_i	=	Disturbance term

A similar model was used by O'Neill and Matthews (1999) in their study on the rate of return to public expenditure on agricultural extension in Ireland where they found that the levels of technical efficiency on farms were influenced by conduct of extension services. Mwakalobo and Kashuliza (1999) used the same model in their study on impact of structural adjustment policies on smallholder farming systems in Tanzania where they concluded that the quantity of fertilizer used was positively related to the revenue obtained from the crop. The same model also used by Philip (2001) in his study on economic analysis of medium scale agricultural enterprises in a predominantly smallholder agriculture sector where the results revealed that there was positive relationship between gross margin and farm size, education level and access to credits.

Regression equations generated by ordinary least square are associated with a number of problems depending on the type of the data used, the nature and form of the regression model employed in the analysis. The common problems encountered in the regression analyses include multicollinearity, heteroskedasticity and autocorrelation (Gujarati, 1998; Maddala, 1998; Philibert, 2007).

This study used cross-sectional and production data; such data are likely to have multicollinearity and heteroscedasticity. The problem with heteroscedasticity is that ordinary least squares estimators while still linear and unbiased can no longer provide minimum variance. This makes the least square estimators unreliable, i.e. the variance will be large leading to small t-values. The small t-value associated with large variance leads to a situation whereby the explanatory variable' parameters are rejected more frequently than necessary. To contend with this situation in the study, a natural logarithm transformation of the dependent variable data was adopted because changing the functional form of the model can treat heteroskedasticity problem.

Another problem associated with multiple regressions is the presence of the multicollinearity. This problem is caused by the existence of the linear relationships among the explanatory variable. Symptoms suggesting the existence of the multicollinearity include: existence of the very high coefficient of determination (R^2), illogical signs of the parameters included in the model and F- ratios being highly significant but most of the individual t-ratios insignificant. Data in this study showed no serious sign of the existence of the problem of multicollinearity.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Socio-economic Characteristics of Household Heads

Socioeconomic characteristics bear essential attribute to socioeconomic and farming practices adopted by farmers. Studying these characteristics is thus important in order to understand general behaviour and attitude of the people referred.

Table 3 shows that the average household size in the farmer managed irrigation schemes is 4.8 people; where there are only slight variations across schemes. The three studied schemes show the average persons per household of 4.2, 5.2 and 4.9 for Mombo, Kivulini and Lekitatu irrigation schemes respectively. This refers to the persons living together as a family, and therefore benefiting from the farming activities done by the members of the family

It has also noted that in all schemes males and female has an opportunity to practice farming in the schemes, although the participation of male is higher than that of the females. On average the participation is 63.1% and 36.9% for males and females respectively. Comparing with the situation Countrywide where agriculture provides work for 14.7 million people, which is about 79% of the total economically active population and where 54% of agricultural workers are female (URT, 2008), it can be learnt that female participation in farming in irrigation scheme is relatively low. Since the participation is not balanced at 50%, the observed percentage indicates more effort especially training on gender aspects is required to enable more females' participation in farming in the farmer managed irrigation schemes.

Grouping farmers into three age groups of Youth (age below 35 years), Adult (age between 35 and 60 years) and Olds (above 60 years), the study shows that on average, percentage participation is 24.4, 41.9 and 33.8 for the youth, adults and olds groups respectively. This reveals the situation where an encouraging percentage of youth joins farming activities in the schemes, an important condition to ensure sustainability and continuity of farming activities in the farmer managed irrigation schemes. Improving male: female participation on farming in irrigation schemes to 50% or better and encouraging more youth to join farming activities; this inline with the National target in Her development vision that states: “By the year 2025, racial and gender imbalances will have been redressed such that economic activities will not be identified by gender or race” (URT, 2000).

Basically majority of farmers interviewed had primary education. Illiterate and those with secondary and higher education are very few percentages wise. The situation indicates that, studied community of farmers has enough education to follow basic knowledge and farming skills if provided. Table 3 also show that on average farmers with primary education marks 73.8% as compared to other groups which shares the remaining percentage. A small percentage (5.6) of farmers with informal education do exist in the schemes, however providing farmer with proper farming knowledge and techniques, improves them irrespective of their education level in the sense that there a lot of practical knowledge and skills that can be adopted.

Table 3: General characteristics of the sample households by schemes

Item		Schemes			
		Mombo	Kivulini	Lekitatu	All
Average Household size (persons)		4.2	5.2	4.9	4.8
Gender of the respondents (%)	(M)	52.5	71.7	61.7	63.1
	(F)	47.5	28.3	38.3	36.9
Age the respondents in categories (%)	Youth (<35yrs)	10.0	33.3	25.0	24.4
	Adult (35-60yrs)	45.0	41.7	40.0	41.9
	Old (>60 yrs)	45.0	25.0	35.0	33.8
Education levels of the respondents (%)	Informal education	7.5	0.0	10.0	5.6
	Adult education	2.5	6.7	1.7	3.8
	Primary	87.5	81.7	56.7	73.8
	Secondary	0.0	11.7	28.3	15.0
	Higher education	2.5	0.0	3.3	1.9

4.2 Land ownership and transfer

The African smallholder irrigators suffer the disadvantages of communal landownership with insecure tenure. The present tenure arrangement does not provide much room and incentive for uninterested farmers to sell out and for interested and capable ones to expand their holdings. Nor does it lead to the emergence of flexible rental markets in irrigated land, thus keeping it from achieving its full productive potential.

Table 4 shows that land ownership varies across studied irrigation schemes. In Mombo irrigation scheme, all land belong to the scheme, that farmers are allocated plots of 0.5 ha each. The procedure is that one has to apply to the scheme management and if the plot is available an applicant can be allocated one plot of 0.5 ha, but before that, the allocation is subject for approval by the committee responsible for plot allocation in the scheme. After land allocation, farmer continue farming the same plot unless fail to adhere to the rules and regulations governing land allocation. Failure to adhere to the scheme rules and regulations (by laws) may lead to one being stopped from farming in the scheme. Some of the rules and regulations include following the cropping calendar properly, farming the allowed crops in this case paddy during long rain season and maize in short rainy season, timely land preparation, paying water and O&M fees timely etc. This type of ownership does not allow land transfer by farmers. If one feel like not to continue farming in the scheme the plot is returned to the scheme management for re-allocation to another farmer. Likewise no renting is officially allowed between farmers.

In other irrigation schemes, in this case Kivulini and Lekitatu irrigation schemes, land is privately owned and thus a farmer can decide what to do with his/her plot including renting and selling. Stopping farmers from farming in the schemes even if not following rules and regulation is difficult unless the scheme has strong leadership system to strongly enforce by-laws. A farmer in Kivulini and Lekitatu schemes owns an average of 0.86 ha and 0.92 ha plot respectively (Table 4).

Different from Mombo irrigation scheme, where every farmer who farms in the scheme owns a plot which is 0.5 ha on behalf of the scheme; in Kivulini and Lekitatu schemes, since plots are privately owned, some farmers do cultivate in the schemes without owning any plots. Such farmers relay on hired plots every season. In table 4 therefore it is shown that minimum farm sizes owned by farmers in Kivulini and Lekitatu schemes are 0.0 ha, this implies that some farmers do cultivate in the scheme but own no plots as they solely depend on hired plots.

Item	Schemes			
	Mombo	Kivulini	Lekitatu	All
Minimum	0.50	0.00	0.00	0.00

Maximum	0.50	3.60	4.80	4.80
Mean	0.50	0.86	0.92	0.79
Std. Deviation	0.00	0.75	0.84	0.71

Kilimanjaro irrigation zone office spokesman, on responding to the question whether there is common rules and/or regulations on land ownership and transfer in the farmer managed schemes, during key informant interview, responded that; there some laws and regulations that differs from scheme to scheme where some are traditional/customary laws. In improved schemes, there are by-laws governed by respective scheme conditions; however in most of them, there is no land re-allocation, although in some improved irrigation schemes, individually owned plots do exists.

4.3 Major Crops Grown

Major crop grown in Kivulini and Lekitatu irrigation schemes is paddy supplemented by maize, beans and vegetables, while farmers in Mombo irrigation schemes grows only paddy and maize. URT (2008) in Her *County profile and Directory*, show that the main irrigated crops in Tanzania are paddy rice and maize, accounting for about 48% and 31% of the irrigated areas respectively in accordance with 2002 data. Other irrigated crops account for 44% of the irrigated areas and are beans, vegetables including onion, tomato and leaf vegetables, bananas and cotton.

Table 5 shows average areas in percentage under major crops per household by schemes. It provides also an average of the same for all studied irrigation schemes. Values in this table reflect that in all studied irrigation schemes farmers allocate more land to paddy than the rest of the crops. This indicates that farmers in most farmer managed irrigation schemes are primarily growing paddy, even if there are shortage of water where other crops can do better because of their low water requirement characteristic. In focus group interview with key informant in the surveyed schemes, comment was given that, farmers are not growing other crops because of various reasons including being not certain to market, limited knowledge and know-how to incorporate farming of other than paddy crops into the existing cropping calendars in their schemes.

Other crops grown in Mombo irrigation scheme include lablab introduced to the scheme recently by researchers from Mlingano research institute aiming at improving soils in rice plots and increasing farmers' income.

Table 5: Average percentage land allocation to various crops by schemes

Type of crops	Land allocation in percentages			
	Schemes			
	Mombo	Kivulini	Lekitatu	All
Paddy	92	50	86.5	76.1
Maize	4	22	8.4	11.5
Beans	0	21	0.9	7.3
Vegetables	0	5	2.5	2.5
Others	4	2	1.7	2.6

4.3.1 Farmers' know-how on crop production

Various studies shows that the potential for enlarging the actual areas of farm land is limited in some countries, so in order to increase output it is deemed necessary to intensify farming practices rather than concentrating on extensive agriculture. Training on new methods of irrigation and better water and soil management practices is perhaps the most valuable assistance that can be provided to farmers (FAO/UNESCO, 1973).

This study evaluated the level of information base farmers has on important farming techniques. In addition study examined the availability and the quality of extension services to farmers.

4.3.2 Extension services

Figure 3 summarizes farmers' responses on the quality of extension services offered by technical personnel in the schemes. The study reveals that a good percentage (54%) of farmers interviewed, value the extension services offered in the schemes as adequate, but also a fairly large number of others (42%) responded that the services are partially adequate. This indicate that although in every scheme there are an extension officer, still the service offered do not quench farmers thirst on getting appropriate and adequate knowledge and skills.

Philip (2001) in his study on economic analysis of medium scale agricultural enterprises in a predominantly smallholder agricultural sector, observed almost the same that 47.2% of the interviewed sugarcane and paddy farmers had access to extension services.

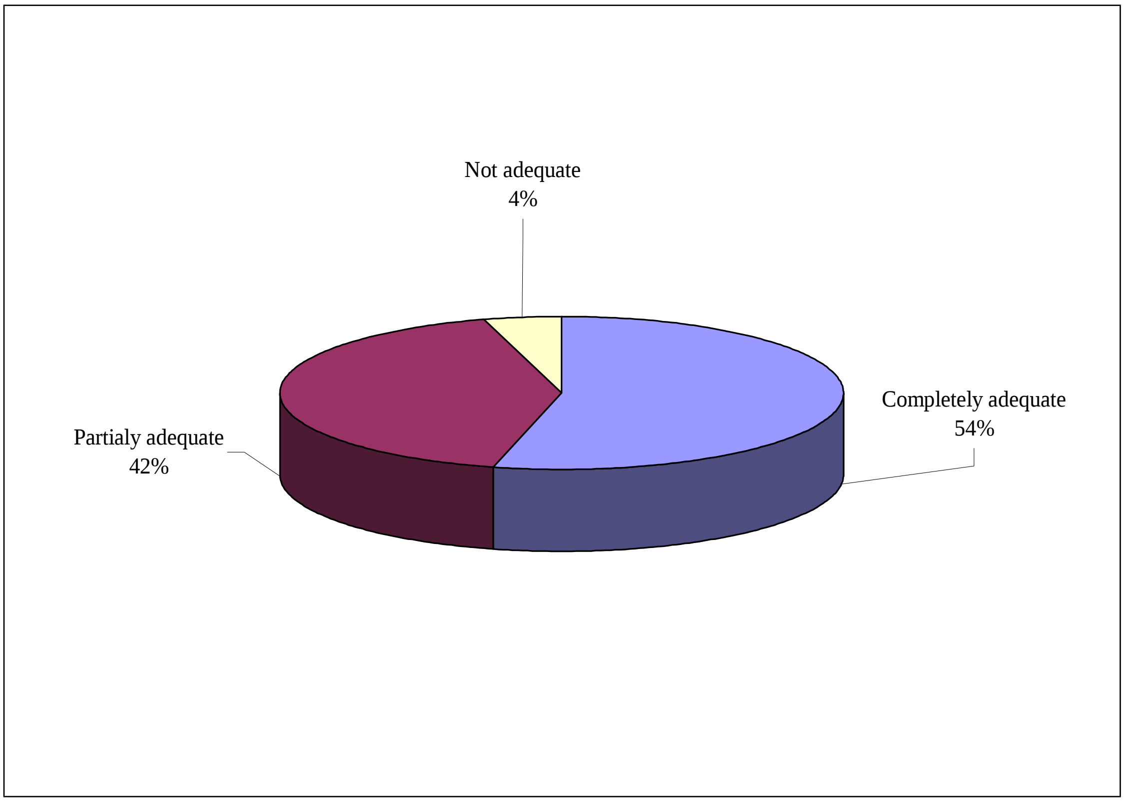


Figure 3: Responses of farmers on the quality of extension services offered in the schemes.

Evaluating farmers' information base on basic farming techniques in irrigated crops, aimed at examining to what extent farmers understand and apply improved irrigated farming techniques. Basic techniques evaluated include: proper bund making, plot levelling, timely weeding and use of improved seeds, irrigation water control and timely harvesting. In summary Fig. 4 shows that on average farmers apply about 60% of the evaluated techniques. This basically implies that training on improved farming techniques on irrigated crops is required in the farmer managed schemes.

Important point to note is that, these techniques are linked to each other such that for any tangible expected results one needs to employ as many techniques as possible. Since most of these technique are difficult to perform individually and some times need the use of machineries that farmers has no access, working in groups serves better.

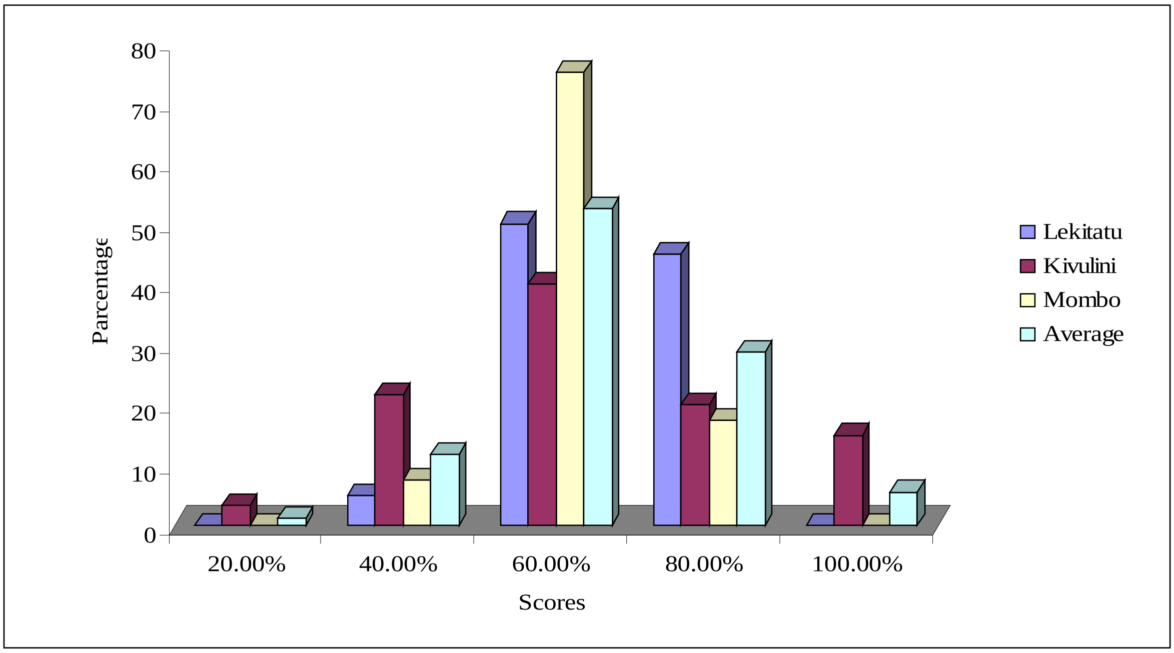


Figure 4: Farmers percentage score in information base on basic farming techniques for irrigated crops.

4.3.3 Use of production inputs

In general inputs are fairly used in the schemes. These include improved seeds, fertilizers, irrigation water and labour. Table 6 shows that 94.7% of the interviewed farmers use fertilizers in paddy production while the use of fertilizers in other crops is as high as 64.6%. In Mombo irrigation scheme all farmers interviewed (100%), uses fertilizers in paddy, while the use of fertilizers in other crops marks 77.5%. In Kivulini irrigation scheme 87.5% uses fertilizer in paddy plots and 42.9% in other crops. The situation is slightly different in Lekitatu irrigation scheme because the use of fertilizers is almost the same for both paddy and other crops. In paddy therefore, 98.2% of farmers use fertilizers while 92.9% of farmers also use fertilizers in other crops. No cases of the substantial manure use reported in any of the surveyed schemes and this is supposed to be among others, because of the difficulties in carrying the sufficient quantities to the distant field plots and in some cases farmers keeps very few or no cattle to give substantial amount of manure required. The information by key informant in these schemes revealed that the use of fertilizers stimulated by the training on improved rice cultivation techniques that some farmers received, which organized and offered by the Kilimanjaro Agricultural Training Centre (KATC), some years ago.

Table 6: Fertilizer use in paddy and in other crops by schemes

Scheme	Using fertilizer in the paddy plots		Using fertilizer in the other crops plots	
	Yes	No	Yes	No
Mombo	100.0	.0	77.5	22.5
Kivulini	87.5	12.5	42.9	57.1
Lekitatu	98.2	1.8	92.9	7.1
All	94.7	5.3	64.6	35.4

All interviewed farmers use improved rice seeds varieties although these are relatively expensive and new seeds needs to be purchased at the beginning of each season by which time farmers have little capital remained. That is why most farmers keep a small proportion of each year’s harvest as next years’ seed, so that new seeds do not need to be purchased at the beginning of the season.

Table 7 shows that all schemes grow improved rice varieties which are *Wahiwahi*, *IR64, IR54, IR56 and SARO.* In Mombo irrigation scheme all farmers grows *IR64,* in Kivulini irrigation scheme farmers grow *IR64*, *IR54* and *IR56* at 49.1%, 35.1% and 15.1%

respectively. In Lekitatu irrigation scheme farmers grow *Wahiwahi* and *SARO* rice varieties at 95.5% and 3.5% respectively.

Table 7: Paddy varieties grown by schemes

Scheme	Paddy varieties grown in Percentages				
	Wahiwahi	IR 64	IR 54	IR 56	SARO
Mombo	0.0	100.0	0.0	0.0	0.0
Kivulini	0.0	49.1	35.8	15.1	0.0
Lekitatu	96.5	0.0	0.0	0.0	3.5

On average 58.3% of the interviewed farmers grows improved maize varieties, whereas the rest (41.7%) grows local maize varieties. Nevertheless there is variability across schemes. Table 8 shows that in Mombo irrigation scheme all farmers use improved maize varieties while in Kivulini and Lekitatu irrigation schemes the use of improved maize varieties is at 45.8% and 77.8% respectively.

Table 8: Maize varieties grown by schemes

Scheme	Maize varieties grown in Percentages	
	Improved	Local
Mombo	100.0	0.0
Kivulini	45.8	54.2
Lekitatu	77.8	22.2
Total	58.3	41.7

4.4 Water management

Water management in this case is reviewed at plot level. The way the farmer manages the water that is allocated to him/her is critical for optimal crop production. Most rules laid down on water use at plot level are not usually enforced. The farmer uses water according to his/her own perceived needs and in most cases does not want to be told what to do with the water that is allotted to them. Farmers are very much aware of their right to a share of the water supply and as such manage their water willy-nilly. Farmers at this level are not monitored (by the scheme, technical personnel and/or other farmers), how effectively they use water that has been allotted to them. The absence of a monitoring mechanism creates a weakness in water management, thus raising questions on sustainability. A poor water management results in reduced crop productivity.

The issue of equity in water allocation is important to avoid chasms between water users in the schemes. To combat inequalities resulting from deliberate water poaching, the irrigation management committees in all studied schemes have set up by-laws that if violated, carry a certain fine. The fines were agreed upon by the farmers when they drafted the constitution. At all schemes, the illegal use of water or violation of a rotation system is met by a fine.

4.4.1 Efficiency in water utilization

In determining water use efficiency the following formulae adopted:

Mathematical expression:

$$\textit{Water Use Efficiency} = \frac{\textit{Total production}}{\textit{Irrigated area}}$$

Total productions for all evaluated crops were in tonne and the irrigated land area in hectare. The study revealed that water use efficiency equivalent to the average yields for the three studied irrigation schemes were 3.87 tones per ha for paddy, 0.55 tones per ha for maize, 0.22 tones per ha for beans and 0.77 for vegetables (Table 9). It is supposed that low water use efficiencies contributed significantly to the low average yields realised. Detailed water use efficiencies for the individual schemes are also shown in the same table. Although there no much variations in water use efficiencies between schemes, generally

Lekitatu irrigation scheme has indicated better water use efficiency compared to Mombo and Kivulini irrigation schemes. However farmers in Mombo scheme cultivated neither beans nor vegetables last season. In all schemes paddy indicated higher water use efficiencies than the rest of crops where the following anticipated being the reason behind this fact:

- ✓ Farmers cultivate paddy as the main crop that their concentration to the paddy plots is higher than for the other crops.
- ✓ Some farmers in these schemes happened to get training on improved farming techniques on irrigated crops, but the training focused mainly on paddy.
- ✓ With their limited resources including capital, farmers find it profitable to invest on paddy because of its higher return.

This on the other had reveal a necessity for all stakeholders in irrigation scheme development to find way of improving other crop farming in the irrigation schemes so that farmers get chances of farming different crops that will allow diversification.

Table 9: Efficiency in water use

Scheme	*Type of crop*	*Irrigated area (ha)*	*Production (tones)*	*Water use efficiency (tones/ha)*
Mombo	Paddy	31.50	122.22	3.88
	Maize	1.40	0.43	0.31
	Beans	N/A	N/A	N/A
	Vegetables	N/A	N/A	N/A
Kivulini	Paddy	20.80	73.84	3.55
	Maize	9.20	7.45	0.81
	Beans	8.80	4.93	0.56
	Vegetables	2.00	3.90	1.95
Lekitatu	Paddy	41.50	173.47	4.18

	Maize	4.00	1.80	0.45
	Beans	0.40	0.01	0.03
	Vegetables	1.20	0.13	0.11
Average (All Schemes)	Paddy	93.80	363.01	3.87
	Maize	14.60	8.03	0.55
	Beans	9.20	2.02	0.22
	Vegetables	3.20	2.46	0.77

4.4.2 Sustainability of irrigated land

Properly irrigated area in the studied schemes for major crops was below 50%. Evaluating the cultivated area in Mombo, Kivulini and Lekitatu irrigation schemes in 2006/7 season, the study revealed that for paddy plots cultivated only 48% of the area properly received irrigation water, 39% for maize, 38% beans and 47% for vegetables (Table 10). The situation engineered partly by bad weather that led to insufficient water abstraction especially for Mombo and Lekitatu irrigation schemes, but principally major reasons are:

- ✓ Poor plot levelling that makes some plots not to receive water.
- ✓ Poor constructed plot bands that allowing water seepage and loses.
- ✓ Unlined and unclean tertiary and plot canals that greatly limit water flow and encourage water seepage.
- ✓ Failure by scheme and block leaders in on side and water committee in the other side to enforce by-laws.
- ✓ Lack of adequate farm machineries that will assist farmers in preparing farm plots properly especially in paddling operation

Analysis by schemes indicated that Mombo irrigation scheme do better in maintaining area initially prepared and aimed at receiving irrigation water correctly. Lekitatu and Kivulini schemes indicate poor performance in maintaining properly irrigated plots. Many reasons might be behind the situation, but one reason revealed by this study is that Mombo irrigation scheme is centrally managed such that plot are communally owned thus enforcing by-laws set to ensure proper water use and distribution is easier. Kivulini and Lekitatu scheme have scheme managements, but plots are privately owned such that control mechanism to ensure proper water managements at plot level becomes comparatively difficult.

Table 10: Sustainability of the irrigated land

Scheme	*Type of crop*	*Area cultivated (ha).*	*Properly irrigated area (ha).*	*Sustainability in properly irrigated land)*
Mombo	Paddy	31.50	29.10	0.92
	Maize	1.40	1.20	0.86
	Beans	N/A	N/A	N/A
	Vegetables	N/A	N/A	N/A
Kivulini	Paddy	20.80	12.30	0.59
	Maize	9.20	3.10	0.34
	Beans	8.80	3.50	0.40
	Vegetables	2.00	1.50	0.75
Lekitatu	Paddy	41.50	4.08	0.10
	Maize	4.00	1.40	0.35
	Beans	0.40	0.00	0.00
	Vegetables	1.20	0.00	0.00
Average (All Schemes)	Paddy	93.80	45.48	0.48
	Maize	14.60	5.70	0.39
	Beans	9.20	3.50	0.38
	Vegetables	3.20	1.50	0.47

4.4.3 Economic value of water

Value of water was calculated only for paddy crop in all three schemes because paddy was the one identified as a major crop in all studied schemes. The calculations based on the data gathered from the respective schemes and district agricultural offices. As shown in table 10, the average value of irrigation water calculated to 14.79 Tsh per m^3 of water. A study by Kadigi *et al.* (2004), on the economics of irrigated paddy in Usangu basin, revealed the average value of irrigation water in Usangu basin to be 26.81 Tsh per m^3 of irrigation water. The study also shows that there is great variability between schemes as far as the question of value of water is concerned. Mombo irrigation scheme for example, have estimated value of water of 6.01 Tsh per m^3 as compared to Lekitatu irrigation scheme with 22.34 Tsh per cubic meter, in spite the fact that these are all farmer managed irrigation schemes. One obvious reason identified was that Mombo scheme suffered serious water shortage last season due to drought.

Average productivity of irrigation water (paddy produced per drop) was very low in all studied schemes (Table 11). The study reveal that average water productivity for Mombo irrigation scheme is 0.03 kg/m^3, while for Kivulini and Lekitatu irrigation schemes are 0.06 kg/m^3 and 0.08 kg/m^3 respectively, giving an average of 0.05 kg/m^3 for all schemes.

Table 11: Estimated value of water for irrigated paddy in the farmer managed schemes (Mombo, Kivulini and Lekitatu, 2006/07 Season)

Parameter	Scheme			
	Mombo	Kivulini	Lekitatu	All
Average revenue from irrigated paddy per season (Tsh)	1 728 350.00	1 649 395.65	2 148 752.96	1 842 166.20

Average non water input cost for irrigated paddy per season (Tsh)	950 615.00	734 083.35	93 2715.62	872 471.32
Average residual revenue attributable to water (Tsh)	777 735.00	915 312.29	1 216 037.34	969 694.88
Estimated seasonal volumetric water demand (m^3)	129 300.74	57 685.33	54 093.10	80 359.72
Estimated average value of irrigation water (Tsh/m^3)	6.01	15.87	22.48	14.79
Average paddy yields (kg/ha)	3 880.00	3 550.00	4 180.00	3 870.00
Estimated average water productivity (kg/m3)	0.03	0.06	0.08	0.05

While it is difficult to specify the main causes for low water productivity; poor plot levelling, leading to poor water control, poor plot bunds and lack of water control structures in the canals e.g. water gates and proper water distribution boxes seem to be some of the major causative factors. Comparing these data with the one obtained in Usangu basin in 2004 in the study by Kidigi *et al.* (2004), which is $0.18 kg/m^3$ and with the average for the Sub Sahara African countries (SSA) which is about $0.25\ kg/m^3$; it is obvious that average water productivity from the studied irrigation schemes is very low.

4.5 Operation and Maintenance

Operation and maintenance (O&M) and agricultural productivity, have a cause and effect relationship, i.e., the sustenance of the one depends on the good performance of the other (Semakande *et al.*, 2007). Basing on the importance of O&M activities in the irrigation schemes the study examined how farmers are involved in O&M activities in the schemes as one of the means of ensuring sustainability.

On responding to the question how do the schemes involve farmers in the operation and maintenance activities in the schemes, spokespersons from zonal irrigation office, district agricultural offices and scheme leaders pointed that farmers are involved in various ways including:

- ✓ Each scheme is sensitized and advised to form an active operation and maintenance committee.
- ✓ Preparing and reviewing operation and maintenance activates schedule at the beginning of each season.
- ✓ Through their operation and maintenance committee preparing O&M by-laws that are there after approved by all members in the general assembly.
- ✓ Almost in all schemes farmers are participate in the communal works that involve various activities to maintain irrigation infrastructures in the scheme.

It is obvious that not all activities can be done by farmers physically, some needs employing skilled person, and some needs materials to purchased etc; in general money requirement in ensuring smooth running operation and maintenance activities is inevitable. To meet this requirement water fee agreed in all schemes include O&M fees. The study therefore evaluated water fee collection rate aiming at establishing facts that at least the scheme can meet the normal O&M requirement or not. The results shows that on average the water fee collection rate is 74.96% although great variation exists between schemes such that evaluation by scheme indicated water fees collection rates of 92.39%, 58.54%, and 79.24% for Mombo, Kivulini and Lekitatu irrigation schemes respectively. The reason for low water fee collection rates in some schemes includes:

- ✓ Lack of an efficient method and modality in collecting fees.

Timing as to when to collect water fee is very important because in most cases farmers has no enough income such that can have enough reserved money to pay at any time. In Mombo irrigation scheme for example water fees payment for the next season is paid during harvesting time this season. This method might not be feasible in other schemes like Kivulini and Lekitatu because in such schemes where plots are privately owned you might not be sure who is going to cultivate that particular plot next season.

- ✓ Failure by responsible leaders to enforce by-laws governing water fee collection.
- ✓ Failure by leaders to prepare and present previous season collection and expenditure report for water fees.
- ✓ Some plots do not receive water properly thus owners hesitate to pay for the service that they are not sure off.

4.6 Return to Labour

The study reveals average return to labour for paddy in the studied irrigation scheme to be 2 072.90 Tsh/man-day, with slightly variations between schemes. Values in Table 12 indicates also that there are very slight variation in average man-days used in paddy farming across studied irrigation schemes. Appreciable amount of return to labour realized encourage improving farming activities in the farmer managed irrigation schemes and that if well strengthened can reduce the rate of unemployment by providing payable jobs to people.

Table 12: Return to labour for paddy crop

Scheme	Average man-days per ha per season	Average net revenue for paddy per ha	Return to labour
Mombo	449.38	777 022.50	1 729.12
Kivulini	477.50	909 467.85	1 904.64
Lekitatu	490.00	1 199 051.43	2 447.04
All	475.16	984 950.36	2 072.90

4.7 Crop Productivity and Profitability

4.7.1 Crop productivity

Average crop productivity (yield in tones per hector), varies greatly across irrigation schemes in all crops except for paddy. The study shows that average maize yield for Mombo, Kivulini and Lekitatu irrigation schemes are 0.31 tones per ha, 0.81 tones per ha and 0.45 toner per ha respectively. Paying less attention to other crops compared to paddy, growing non improved seeds (Table 8) and some farmers using no fertilizers in crops other than paddy might be among reasons, why maize yield is low in all studied schemes. Average yields for beans is 0.56 tones per ha for Kivulini and 0.03 tones per ha for Lekitatu irrigation schemes. On the other hand average paddy yield for Mombo irrigation scheme is 3.88 tones per ha and that for Kivulini and Lekitatu irrigation schemes are 3.55 and 4.18 tones per ha respectively; giving an average of 3.87 tones per ha for all studied irrigation scheme (Table 12).

The average paddy yield (3.87 tones/ha) from the studied irrigation schemes is slightly higher than the National paddy yield average of about 2 tones per ha. The following might be among others the contributing reasons for the better performance of the studied irrigation schemes. First these irrigation schemes are all in Kilimanjaro irrigation zone where the famous Lower Moshi irrigation scheme is located. Lower Moshi irrigation scheme is one of the schemes that had its irrigation infrastructure well developed and thereafter received intensive training on irrigated paddy cultivation techniques in 1980’s. These improvements turned the scheme to be one of the superior schemes in irrigated paddy production in the country. Lower Moshi irrigation scheme ones marked an average paddy yields above 6 tones per ha before retardation due to water shortage and other management factors. Therefore Farmers in Mombo, Kivulini and Lekitatu irrigation schemes adopted many good cultivation techniques and practices from Lower Moshi farmers. The second reason is that farmer in these schemes grows improved paddy varieties which are basically high yielding varieties (Table 8a). Another reason is the use of fertilizers in paddy production, which promote and increase yields.

Table 13: Crop productivity (yield) in tones per hector for the major crops by schemes

	Yields in tones per ha by schemes			
	Mombo	Kivulini	Lekitatu	Average
Paddy	3.88	3.55	4.18	3.87
Maize	0.31	0.81	0.45	0.55
Beans	-	0.56	0.03	0.22
Vegetables	-	1.95	0.11	0.77

4.7.2 Crop profitability

As shown in Table 14, profitability from crop enterprise varies slightly among schemes, with an average of 1 162 751.16 Tsh/ha and that Mombo irrigation scheme marked the least average profitability (841 428.75 Tsh/ha). Although farmers in these schemes complained the increased costs of production especially due to increased inputs and labour costs, the realized profitability is fairly good. In addition data revealed that higher profitability is realized from paddy than from other crops. Low profitability realized in Mombo scheme contributed partly by drought problem on one hand and the lack of the supplementary crop farming on the other hand.

Table 14: Farm enterprise budget for Crops enterprise

	Schemes			
Item	Mombo	Kivulini	Lekitatu	Average
Receipts				
Average income per household from paddy sales per ha	1 728 350.00	1 649 395.65	2 148 752.96	1 856 393.23
Average income per household from maize sales per ha	62 512.50	153 868.06	100 041.67	110 844.27
Average income per household from beans sales per ha	0.00	443 611.12	20 000.00	173 854.17
Average income per household from vegetable sales per ha	0.00	180 833.33	21 450.00	75 856.25
Total sales	1 790 862.50	2 427 708.15	2 290 244.63	2 216 947.92
Itemized costs per ha				
Seeds	24 625.00	97 322.14	67 415.28	67 932.78
Fertilizer	123 825.00	123 326.39	158 846.23	136 770.98
Insecticide	18 175.00	50 138.89	55 070.63	43 997.32
Water charges	793.75	8 830.56	19 569.25	10 848.36
Hired labour	672 785.00	532 687.60	544 858.43	572 276.01
Family labour	68 980.00	335 590.67	180 986.16	210 961.31
Other (fixed) costs	40 250.00	3 293.33	300.00	11 410.00
Total costs	949 433.75	1 151 189.58	1 027 045.98	1 054 196.76
Profitability	841 428.75	1 276 518.57	1 263 198.65	1 162 751.16

Farmers in Kivulini and Lekitatu schemes grow beans and vegetables during short rain season, these crops do better than paddy whenever there are problems of water shortage. In Mombo scheme farmers has to grow crops that have been agreed and put in the cropping calendar, while in these other schemes individual farmers are allowed to choose types of crop they would like to grow. Nevertheless the majority grows paddy as their main crop.

In addition to yield increase and profitability realized, farming in the scheme has several benefits as summarized in Table 15, following farmers' responses during interviews. Interview data was supplemented by direct observation during transects walk across the villages and in the scheme farms; together with focus group interviews.

Table 15: Benefits realized by faming in the scheme

Type of Benefit	Counts	Percentage of the responses
Food Security to the family	98.1	22.1
Meet education requirement of the family	85.0	19.2
Meet dressing requirements	85.0	19.2
Meet health requirements of the family	84.4	19.0
Built a modern house	71.3	16.1
No remarkable benefits realized	20.0	4.5
Total	443.8	100.0

n = 160.

4.8 Major problems facing farmer managed schemes

The URT - Country profile and Directory (2008), identifies the following as the main problems facing irrigation development in Tanzania:

- Lack of appropriate participatory approaches;
- Unsound logical structure of projects and weak linkage between purpose and output of projects;
- Misunderstanding of the concept of "simple and low-cost technology", taken to mean "easy and no concern of technical know-how and understanding";

- Lack of feedback system on the lessons learnt through actual experience in implementation of irrigation projects;
- Inadequate guidelines and manuals in planning, design and construction supervision, and lack of proper application of them;
- Need of effective support system to water users associations (WUA) and/or irrigators groups (IG) activities;
- Lack of human resources and active participation of Local Government Authorities in irrigation development;

This study revealed that in spite of fairly good yields, profitability and other benefits realized, interviewed farmers' pointed out some problems. Table 16 shows major problems as disclosed by farmers. Generally failure to rehabilitate the existing irrigation structures and plots with salts affected soils are the major problems in all three schemes studied. This makes the sustainability of irrigation infrastructure and productive lands questionable. All mentioned problems in other hand are solvable if all stakeholders could agree and decide to share hands in improving farmer managed irrigation schemes. A collective responsibility among stakeholders is highly required.

Table 16: Response of farmers on problems in farming in the schemes

Problem mentioned	Counts	Percentage
Broken irrigation infrastructures (canals, plot bunds,		

drainage etc).	65	21.2
Salts affected plots	64	20.9
Poor farm roads and crossovers	23	7.5
Unfair water distribution system	23	7.5
Poor plot levelling	23	7.5
Blocked or dirty canals and drainage	22	7.2
Incomplete construction of irrigation structures	19	6.2
Bylaws not enforced	19	6.2
Inadequate farming techniques	18	5.9
High price and untimely arrival of farm inputs	12	3.9
Financial report delayed	10	3.3
Water shortage	6	2.0
Lack of transport facilities for technicians	2	0.7
Total responses	306	100.0

4.9 Regression Analysis

To test the effect of various factors, which were hypothesized to influence farmers' income in the irrigated schemes, regression equations were estimated. This equation aimed at examining the influence of farmers characteristics (age, gender, education), farm size, technical information farmers' has on irrigated farming, irrigation water availability, invested capital, type of land ownership, access to credit, contribution of supplementary crops and selling prices for paddy, maize, beans and vegetables on farmers' income from farming in the scheme. The equation examined the effect of the mentioned factors to dependent variable `income from farming` in the three studied schemes (Mombo, Kivulini and Lekitatu) all together. Table 17 gives the summary of independent variables used in the regression analysis showing clearly the form and units that the variable takes.

Table 17: Summary of the independent variable used in regression analysis

Variable estimated	Description
AGE	Age of the respondents in years
EDU	Education level of the respondents (1 = Informal education, 2 = Adult education, 3 = Primary education, 4 = Secondary education, 5 = Higher education).

GENDER	The sex of the respondent (Dummy variable where: 1 = Male, 0 = Female)
FS	Farm size cultivated by the respondent for 2006/7 season (ha)
IWA	Irrigation water availability measured at three intervals 0, 1 and 2 where 0 = Not enough, 1 = Partially enough, 2 = Quite enough.
TIB	Technical information base index ranked in percentages at an interval of twenty percent ranging from 0% to 100%.
LO	Type of land ownership ranked in two ranks (Dummy variable where: 0 = communal, 1 = Private).
AC	Access to credits (Dummy variable where: 0 = No, 1 = Yes.)
CPT	Capital invested in farming in 2006/07 season in Tsh.
OCI	Contribution of supplementary crops in percentages.
PRp	Price for paddy in Tsh/kg.
PRm	Price for maize in Tsh/kg.
PRb	Price for beans in Tsh/kg.
PRv	Price for vegetables in Tsh/kg.

4.9.1 Expected signs from the variables' coefficients

AGE: Age of the respondents.

It was anticipated that elder farmers had experience on farming specifically on irrigated farming such that they are expected to perform better than younger farmers. This variable expressed in terms of number of years, thus expected to carry positive sign.

EDU: Education level of the respondents.

Education level is expected to affect farmers' farming income positively because as a farmer becomes educated, his/her ability on understanding and implementing techniques delivered expected to increase.

GENDER: Sex of the respondents

Irrigated farming is considered to heavy job especially land preparation and weeding for women although it is normally giving good income if comprehensively performed. It was therefore anticipated that gender could affect farmers income in such a way that majority of men as compared to women do farming in the schemes thus gets more income from irrigated farming than for female.

FS: Farm size.

Farm size was expected to influence income positively such that the larger the plot/farm sizes the better the income to farmers.

TIB: Technical information base.

Technical information base index included five basic techniques involved in irrigated farming. The basic techniques in question include: Proper plot bunds construction, plot levelling, proper irrigation water management skill, use of quality seeds and timely weeding. It was expected that the more farmer become expert in employing these basic techniques, the income increase hence give positive sign.

IWA: Irrigation water availability

It was expected that the availability of irrigation water could increase crop yield and hence increase in income. Therefore irrigation water availability and farmers' income are expected to be positively related.

CPT: Capital

Proper and timely farming operations accomplishment as well as timely purchases and application of farm inputs depends on the capital available. Therefore it was expected that capital would affect income positively such that the great the capital invested in farming the higher the income.

AC: Access to credits

It was expected that access to credit give farmers an opportunity to improve their capital hence affect income positively.

LO: Type of land ownership

It was supposed that plots owned individually receive more care than those owned communally. Therefore privately owned plots affect income positively and vies versa.

OCI: Contribution of supplementary crops

The percentage contribution of supplementary crops was estimated. It was expected that supplementary crops generates appreciable amount of income to supplement total farming income. Therefore this parameter was expected to carry positive sign.

positively. Therefore the higher the price the better the income expected.

4.9.2 Analysis results

The results in Table 18 show that all coefficients as expected were positively related to the dependent variable, and that collectively the estimated variables as indicated by the F- value ($F = 56.2$) were statistically significant ($p>0.05$). In addition the majority of the individual parameters attached to the estimated variables were also statistically significant ($p>0.05$).

- ✓ The results revealed that farmers' characteristics estimated i.e. age; education level and gender were all statistically insignificant. The results therefore suggest that age of the respondent had no notable effect on farmers' income. Education level as well as gender of respondents on the other hand indicated positive relationship to the independent variable, but their effects are not significantly notable. The insignificancy of these farmers' characteristics was due to the fact that all farmers irrespective of their ages are having an opportunity to farm in the scheme. On the other hand farmers in these schemes received training on proper irrigation farming techniques organised by the KATC that were basically effective, practical and easy to implement such that there was no variations signified by education level differences in adoption.

- ✓ The positive relationship between the average plot size cultivated and the income earned can be attributed to the fact that in average farmers in the schemes owns or cultivates relatively small plots (0.79 ha per household). Another fact is that most farmers use family labour in exhaustion before opting for other source of labour.

- ✓ The positive relationship between the availability of irrigation water and the income earned can be attributed to the fact that plots receives different quantities of water depending on where the plot located in the scheme and the level of canals cleanness as well as whether the canals that commands water are broken or not. There was great difference on the access to water among farmers, which was due to the following reasons:

- o Irrigation infrastructures especially canals in most cases are not regularly cleaned hence impede water from running resulting to farm plots at far ends receive very little water as compared to the plots near heads.
- o There no systematic rehabilitation program such that broken or worn out infrastructures especially canals limits smooth running and distribution of irrigation water.
- o In some schemes water distribution plans are not correctly observed.
- o Poor level of the plots makes water insufficient to crops.

- ✓ The insignificance of the parameter attached to the capital invested attributed to the fact that since farmers cultivate no large farms (average of 0.5, 0.8 and 0.9 hectares for farmers in Mombo, Kivulini and Lekitatu schemes respectively); this means most farmers keep enough capital such that capital is not a limitation for increasing income.

- ✓ Land ownership styles that exist in the studied schemes are only two, i.e. Communal and private. It was anticipated that private style is superior to communal ownership. The results therefore suggest that land ownership significantly affect farmers' income. This can be attributed to the fact that plots owned privately receive more attention than communally owned ones, including levelling, properly constructed bands, improving soil fertility etc. This generally improves income significantly.
- ✓ Positive relationship between selling prices of paddy, maize and beans based on the fact that paddy and maize were produced in large quantities whereas beans though

not produced in same quantities as paddy and maize its price was high enough to cause appreciable effects on income earned.

- ✓ The insignificance of the parameter attached to the selling price of vegetables aroused from the reason that vegetable as a supplementary crop was cultivated at very small magnitude compared to the rest of crops.

It can be noted from the results (Table 18) that the coefficient of determination (R^2) is 84.4%, meaning that the independent variable all together account for 84.4% of the total variations in the farmers' income. On the other hand the results suggest that 15.6% of the variations in the farmers' income are attributed to other factors not included in the model.

Table 18: Regression analysis results for the all schemes together

Variable	B	Std. Error	T-ratio
Constant	10.917	0.320	34.075*
Age of the respondent	0.000	0.003	0.120
Education level of the respondents	0.001	0.048	0.019
Gender (Sex of the respondent)	0.048	0.066	0.726
The plot size cultivated by the respondents in the scheme	0.123	0.045	2.710*
Irrigation water availlability	0.538	0.058	9.348*
Information base on basic irrigated farming techniques	0.144	0.042	3.385*
Type of land ownership	0.242	0.083	2.894*
Access to credit facilities	0.233	0.098	2.380*

Capital invested in farming in the season 2006/7	0.000	0.000	1.400
Contribution of supplementary	0.001	0.000	3.207*
Selling price paddy per kg.	0.001	0.000	3.508*
Selling price maize per kg.	0.001	0.000	2.404*
Selling price beans per kg.	.000	.000	2.383*
Selling price for kg of vegetable	.001	.001	1.454

Note: $\bar{R}^2$ = 82.9% R^2 = 84.4% SE = 0.375 F-value = 56.2*

* = Significant at 5%

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Several principal findings emerged from the analyses in relation to the hypotheses formulated to address the study objectives.

The first objective of this study was to examine crop profitability, productivity and economic performance of the farmers-managed irrigation schemes. To address this objective the study hypothesized that farmers-managed irrigation schemes are not operationally efficient. The testing of this hypothesis was based on profitability and productivity estimation as well as performance determination. Profitability was measured using farm enterprise budget analysis, whereas productivity measured using yield determination. On the other hand scheme economic performance was measured by determining return to labour. The results revealed that the studied farmers-managed irrigation schemes had average profitability of Tsh 1 162 751.00 per ha. Average yields observed to be 3.87, 0.55, 0.22 and 0.77 tone/ha for paddy, maize, beans and vegetables respectively. Economic performance revealed that average return to labour for paddy crop in the studied schemes observed to be 2072.90 Tsh/man-day. Since the study revealed positive profitability and fairly good crop yields, it can be concluded that farmers-managed irrigation schemes are operationally efficient.

The second objective was to assess farmers’ technical efficiency in irrigated water utilization in the schemes in terms of water use efficiency and productivity. To address this objective the study hypothesized that irrigation water is not efficiently utilized in farmers-managed schemes. The testing of this hypothesis was based on determination of efficiency in water utilization and economic value of water. Efficiency in water utilization was measured using water use efficiency and economic value of water measured by estimating value of irrigation water and water productivity. The results revealed that water use efficiency observed to be 3.87 tones/ha for paddy, 0.55tones/ha for maize, 0.22 tones/ha for beans and 0.77 tones/ha for vegetables. On the other hand average value of irrigation water observed to be 14.79 Tsh/m^3 and average water productivity was 0.05 kg/m^3. Following the observed low water value and productivity it can be concluded that irrigation water is not efficiently utilized in the farmers-managed irrigation schemes in Tanzania.

The third objective was to determine the rate of farmers' contribution and involvement in carrying out operation and maintenance activities in the scheme. To address this objective it was hypothesized that social economic characteristics of farmers do not affect water use efficiency regardless of the management type. To test the hypothesis descriptive statistics was employed to determine water fee collection efficiency and sustainability of irrigated land in the studied schemes. Major problems, which negatively influenced farming in the farmers-managed irrigation schemes was also determined. The results revealed that water fee collection efficiency observed to be 74.96%, while the sustainability of irrigated lands was 48%, 39%, 38% and 47% for paddy, maize, beans and vegetables respectively. Among other problems, broken irrigation infrastructures (canals, plot bunds and drainage), salt affected plots, poor farm roads and farm plot cross-over, unfair water distribution plans and blocked or dirty canals and drainage ranked high as major problems affecting irrigation farming in the farmers-managed irrigation schemes in Tanzania. From the results it can be concluded that although it is very important to ensure that water fee is paid effectively, it is also necessary to look into solutions for the major problems that are facing farmers in the schemes. This is deemed necessary because sustainability of irrigated area in all schemes observed to be below 50%.

The fourth objective was to identify factors that influence performance of the farmers-managed irrigation schemes. To address this objective it was hypothesized that technical and institutional factors do not influence farmers' income in the farmers-managed irrigation schemes. The testing of this hypothesis was achieved by running multiple regression analysis. Farmers' income from farming was regressed against social-economic variables. The results revealed that farmers' income from farming was significantly affected by the regressed variable (statistically significant $p>0.05$). In addition most of the independent variables were positively related and statistically significant ($p>0.05$) to the dependent variable. From the results it can be concluded that the average plot size cultivated by farmers, irrigation water availability, basic knowledge on irrigated farming techniques, access to credit, type of the land ownership and strengthening the contribution of supplementary crops to farmers' income are areas that need strong attention in improving farmers-managed irrigation schemes in Tanzania.

Despite current operational and technical problems facing farmers, in these farmers-managed irrigation schemes, it has also been observed that farmers-managed irrigation schemes have significantly contributed to both food security and cash income. An income that generates average profitability of about 1.1 million per season is actually good, especially when compared to income from other farming system including rain fed. This scenario shows that, improving farming in the farmers-managed irrigation schemes has the potential to alleviate poverty and ensure year round food security to the farming community in the irrigation schemes and at national level.

5.2. Recommendations

Following observations revealed by this study, the following recommendations are given:
Under the current improving and empowering exercise of farmers-managed irrigation schemes, it is important that farmers put in place proper monitoring and evaluation mechanism to ensure the efficient use of resources (water and infrastructure). It should however be appreciated that farmers have tried to enforce enacted bylaws through the use of graduated sanctions; a principle essential for efficient schemes management.

Farmers should also be fully empowered with infrastructure use rights but making sure that all other stakeholders, partners and collaborators in the process of improving and managing irrigation scheme are identified and that their roles and responsibilities clearly known. Currently, only part of this right (operation and maintenance) is exercised by the farmers. This has led to unwillingness to invest in long-term maintenance and repair as they regard infrastructure as government property. Generating a sense of ownership will lead to better investment and proper management of this common property resource.
In addition specific recommendations here follow:

1. Local government and irrigation zones should work hand in hand with scheme managements and farmers to ensure good management and smooth run of the irrigation schemes.

2. Training should be organized for farmers in the schemes to be trained on improved irrigated crops cultivation, irrigation water management and control, farm management, economics and marketing skills at farmers level and fabrication and use of simple but improved farming tools and equipments.

3. Financial institutions including banks, the government and NGO's should consider giving rural farmers including farmers in irrigation schemes soft loans to enable them purchase basic farm inputs and other requirements.

4. Local government should ensure farmer managed irrigation schemes have agricultural extension officers with a strong background in irrigation.

5. Water use efficiency need to be improved through the rehabilitation of all canals, distribution boxes and encourage and supervise farmers to make strong plot bunds, while water management committee produce and adhere to an agreed water distribution plans.

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APPENDICES

Appendix 1: Questionnaire for Farmers

Questionnaire No……………….

Date of Interview………………..

A. General Information

1. Name of respondent …………………………………………………..
2. Name of the Scheme…………………………………………………..
3. Age of the respondent……………………years
4. Sex of the respondent…………..Male/Female
5. Marital status of the respondent.
   - i. Single ( )
   - ii. Married ( )
   - iii. Divorced ( )
   - iv. Widowed ( )
6. Education level of the respondent?
   - i. Informal education ( )
   - ii. Adult education ( )
   - iii. Primary education ( )
   - iv. Secondary education ( )
   - v. Higher education ( )
7. What is the role of the respondent in the scheme:
   - i. A scheme leader ( )
   - ii. A member of the committee ( )
   - iii. A block leader ( )
   - iv. A farmer ( )
   - v. Others (specify)………………………………………………

B. Land ownership and Value

8. What is the total size of the plot/field belonging to you in the scheme ……… acres

9. What is the total size of the plot/field you cultivated in the scheme during 2006/2007 season…………………… acres
10. Out of the total field you own in the scheme, what size of the field you rented out in 2006/07 season... … … … … … … acres.
11. Out of the total field you cultivated in the scheme in season 2006/07, what was the farm size that properly received irrigation water for:
    i. Paddy... … … … … … … acres
    ii. Maize... … … … … … … acres
    iii. Beans... … … … … … … acres
    iv. Vegetables... … … … … acres
12. Can you sell the plot you own to another person? YES / NO
13. If YES what was the price of one acre plot in 2006/07 season? ………Tsh
14. What was the price of renting one acre plot in 2006/07 season? …… Tsh
15. How much money have you spent in 2006/07 season as capital in farming activities …………Tsh

16. Family member and composition:

s/n	Name of the family member	Age	Sex	Education level
1				
2				
3				
4				
5				

C. Information on income from crops

17. What was the crop production you obtained in 2006/07 season?

s/n	Type of crop	Area grown (acres)	Variety	Total harvest
1.	Rice			
2.	Maize			
3.	Beans			
4.	Vegetables			

18. Crops marketing 2006/07 season

s/n	Type of crop	Unit of measure	Unit prices	Total value
1.	Paddy			
2.	Maize			
3.	Beans			
4.	Vegetables			

19. Production costs for Paddy:

a. Input (material) costs

s/n	Item/Operation	Costs
i.	Variety	
ii.	Size of the plot/field cultivated (acres)	
iii.	Cost of seeds	
iv.	Costs of fertilizers	
v	Insecticides costs	
vi.	Water charges	
vii.	Other costs	

b. Labour costs

s/n	Item/Operation	Hired Labour used (man days)	Family labour (man days)	Costs per man day
i.	Size of the plot/field (acres)			
ii.	Land clearing			
iii.	Bund repairing			
iv.	Ploughing			
v	Paddling			
vi.	Nursery preparation			
vii.	Field levelling			
viii.	Transplanting			
ix.	Costs of Weeding			
x.	Costs of fertilizers application			
xi.	Insecticides application costs			
xii	Bird scaring			
xiii.	Harvesting			
xiv.	Transportation from the field			
xv.	Other charges			

20. Production costs for other crops

a. Inputs (material) costs

	Item	Maize	Beans	Vegetables
i.	Size of the plot/field			
ii.	Cost of seeds			
iii.	Costs of fertilizers			
iv	Insecticides costs			
v.	Water charges			
vi.	Other charges			

b. Labour (Hired) costs

	Item	Maize		Beans		Vegetables	
		Man-days	Cost per Man-day	Man-days	Cost per Man-day	Man-days	Cost per Man-day
i.	Size of the plot/field						
ii.	Land preparation						
iii.	Ploughing						
iv.	Planting						
v	Costs of Weeding						
vi.	Costs of fertilizers application						
vii.	Insecticides application						
viii	Harvesting						
ix.	Transportation from the field						
x.	Other charges						

a. Labour (Family) costs

	Item	Maize		Beans		Vegetables	
		Man-days	Cost per Man-day	Man-days	Cost per Man-day	Man-days	Cost per Man-day
i.	Size of the plot/field						
ii.	Land preparation						
iii.	Ploughing						
iv.	Planting						
v	Costs of Weeding						
vi.	Costs of fertilizers						

	application						
vii.	Insecticides application						
viii	Harvesting						
ix.	Transportation from the field						
x.	Other charges						

D. Benefit from farming in the scheme

25. What are the benefits you get from the scheme?

i. Food security
ii. Managed to build good house
iii. Able to meet health requirement for the family
iv. Able to meet education requirement for the family
v. Able to meet dressing requirement
vi. Others (specify) …………………………………………….

26. What is the trend of your income from farming activities in the scheme?

i. Increasing
ii. Decreasing
iii. No change

E. Farming techniques for Rice

27. Do you repair/construct plot bund before plowing or paddling? Yes/No

28. Did you level your field at paddling? Yes/No

29. Do you transplant in line or random? Line /Random

30. How many days after transplanting do you conduct 1st weeding? ( ) days

31. Do you use fertilizer in rice cultivation? Yes/No

32. Was the irrigation water sufficient to make the crop grow well

i. Quite enough
ii. Partially enough
iii. Not at all

F. Farming techniques for other crops

33. Do you repair/construct plot bund before plowing Yes No

34. Did you level your field at before planting? Yes No

35. How many times did you weed? ( ) times
36. Do you use fertilizer? Yes No
37. Was the irrigation water sufficient to make your crop mature well?
    i. Quite enough
    ii. Partially enough
    iii. Not at all

G. Information Base on Farming technique in the scheme

38. Do you know how to construct farm bands?
39. Do you know how to level farm plots?
40. Do you know water requirements for various crops?
41. Do you know what are the appropriate seeds and how to do proper seed preparation for various crops?
42. Are you aware of timely weeding?

H. Other information

43. Are you a member of the farmers' organization in the scheme? YES/NO
44. Have you paid organization contributions in the last season? YES/NO
45. How much you were supposed to pay in total? …………………… Tsh
46. How much you managed to pay? ………………………………….Tsh
47. Are there any technical personnel in the scheme? YES / NO
48. On your opinion, are the technical advices or services provided adequate?
    i. Completely adequate ( )
    ii. Partially adequate ( )
    iii. Not adequate ( )

49. Are there any organization providing credits in terms of capital, inputs, operation services etc. to farmers' in the scheme? YES / NO.

50. Accesses to credits:

Source	Accesses		
	Easy	moderate	Difficult
Farmers' organization			
District council			
Banks			
NGO			
Other Organizations (specify)			

51. How much credits have you received in 2006/07 season for farming activities? ……………. Tsh
52. What are the interest rates for the credit offered?

53. What kind of machineries did you use in the field 2006/07 season?

………………………………………………………………………………………

54. What are the problems related to the scheme leadership and operation?

………………………………………………………………………………………………
………………………………………………………………………………

55. What are the problems related to the fields/farms structures and water management?

Appendix 2: Probe Questions (Checklist) for the technical Personnel and Scheme leaders

1. When did the scheme established?
2. What is the total are of the scheme?
3. What are the main crops grown?
4. What is the size of the scheme that is:
    a. Well developed ………………. aces
    b. Not developed………………….acres
5. What strategies do you have to develop the remaining area?
6. What is the area that was initially constructed and was able to be irrigated?
7. What is the actual are that can be irrigated now?
8. What factors led to the previous irrigable area turn to non-irrigable area?
9. What rules and regulations governing land allocation, ownership and /or transfer in the scheme?
10. What is the price of one acre of the land in the scheme? ………… Tsh
11. What is the price of one acre of the land out of the scheme? ………… Tsh
12. Are all the beneficiaries in the scheme members of the farmers' organization?

    How many are not?
13. Why are they not members?
14. What contributions to the organization a farmer is obliged to pay in a year or season?
15. What is the average rate of farmers' payments of their dues per year or season?
16. What were the total collection/ income the scheme realized in 2006/07 season?
17. Out of farmers' contribution to the scheme how much is for water fee per farmer per season?
18. In 2006/07 season what was the expected water fee collection? ………. Tsh; the actual collection was …………………….. Tsh
19. What was the average expenditure by the scheme in 2006/07 season?
20. How do you involve farmers in O&M activities?
21. Does the scheme have water right?
22. What is the amount of water the scheme is allowed to abstract as per water right?
23. In which months the scheme got enough water in the season 2006/07?

24. What is the management structure of the scheme?
25. What are the obligations of the local government (district council) to the scheme? the sc
26. What are the obligations of the irrigation zone office to the scheme?
27. What are the main problems facing the scheme?

Appendix 3: Probe Questions (Checklist) for the Irrigation Zone office

1. What are the obligations of the irrigation zone office towards improving performance of the irrigation schemes and particularly farmer managed scheme?
2. Are there any rules and regulations governing land allocation, ownership and /or transfer in the scheme?
3. If YES, are they the same in all schemes?
4. What are they in brief?
5. What kinds of organization are you advocating that farmers should form and why?
6. How do you involve farmers in O&M activities?
7. Is it necessary that every scheme get the water right? Why?
8. Whose responsibility to make sure that the scheme gets the water right?
9. Is there any common management structure of the farmer managed schemes? What is it?
10. Who design or propose the management structure of the scheme?
11. How do you collaborate or involve other stakeholders in the process of improving irrigation schemes?
12. In respect to this, who are your main partners?
13. Generally, what are the main problems facing most farmer managed schemes in this zone?

Appendix 4: Probe Questions (Checklist) about Technical information on Irrigation schemes at the Headquarter

1. What kinds of rules and regulations governing land allocation, ownership and /or transfer in the schemes?
2. What is the opinion of the ministry on the involvement of farmers in O&M activities?
3. What are the criteria governing the acquisition of the water right for the scheme?
4. Does the ministry have the proposed management structure of the scheme?
5. What are the obligations of the local government (district council) to the scheme as identified by the ministry?
6. What are the obligations of the irrigation zone office to the scheme as identified by the ministry?
7. What are the main problems facing the scheme?
8. Are there any literature regarding farmer managed irrigation scheme
    - origin
    - operation
    - performance
    - problems
    - condition
        - hard ware
        - Soft ware